Star-Pilot's Guide

Microsoft Home

Microsoft Space Simulator

Go to the Edge of the Galaxy—and Beyond

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Star-Pilot's Guide

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Contents

Welcome

"For those who have seen the Earth from space, and for the hundreds and perhaps thousands more who will, the experience most certainly changes your perspective. The things that we share in our world are far more valuable than those which divide us."—Donald Williams, American astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Get the most from Microsoft® Space Simulator and the *Microsoft Space Simulator Star-Pilot's Guide.*

Welcome to Microsoft Space Simulator, the program that transports you instantly into space, where you see our great blue marble of a planet from the cockpit of an interstellar spacecraft. From this orbiting start you can travel to the Moon, to Mars, or to any other destination you like, including the far ends of the galaxy.

To make piloting your spacecraft easier, you can set your own skill level, but you always experience space as it really is—complete with gravitational attraction for moons, planets, and stars. And, just as in real space, all these objects are in continual orbital motion.

Explore the galaxy—here are just some of the features that Space Simulator offers!

Your personal gateway to the galaxy Space Simulator offers voyages into space that are otherwise out of reach to most people—possibly for generations to come. What Microsoft Flight Simulator™ does for would-be (and actual) pilots, Space Simulator does for those who long to launch into space. You can now sit down at your computer and travel to the stars.

Operating in real time, you can take a four-day trip to the Moon, an eight-month trip to Mars, or, if you've really got time on your hands, a 450,000-year journey to the core of our galaxy.

Fortunately, Space Simulator also gives you the option of accelerating and decelerating the passage of time, which means you can fly through the very heart of our galaxy and still be home in time for dinner!

"Installing and Starting Space Simulator," on page 1, guides you through the simple process of installation. After that, it is farewell to Earth, and hello to space.

Space Simulator's world Space Simulator's world is a realistic simulation of our solar system and the surrounding Milky Way galaxy, with virtual space encompassing a diameter of 8.4 billion light-years. A single light-year is equal to 9.46 trillion kilometers (6 trillion miles), which means that when you enter the world of Space Simulator you have an unimaginably vast realm of uncharted space to explore. There's more than a lifetime of exploration!

About the spacecraft An entire fleet of spacecraft awaits you. The vehicles range in size from a compact manned maneuvering unit (MMU) to an interplanetary passenger transport and a giant interstellar freighter. You can orbit Earth in something as familiar as a space shuttle or patrol the far side of the galaxy in a science-fictional galactic explorer.

If you need a definition or an explanation of a term, check the Glossary on page 198.

Space missions For challenging entertainment, Space Simulator offers special missions. In the Space Shuttle mission, you can take off from Cape Canaveral, dock to a space station, and practice your landings when you arrive back home. In the Apollo 17 mission, you can orbit the Moon, control your descent and landing, and then blast off again for Earth. The galaxy holds great treasures and Space Simulator's special missions provide an exciting way to see new worlds.

Recording your adventures Along the way you can chronicle your adventures, discoveries, and piloting finesse by using the Video Recorder and Camera commands on the Options menu.

Autopilot and flight computer Sit back and relax on your journey to the stars. Use the autopilot to maneuver your spacecraft to a docking port, adjust your orbits, or fly to a rendezvous with an asteroid or a comet, and then link these and other autopilot actions into a complete flight plan with the flight computer.

If you want to start flying right away, choose Open Situation from the Options menu, and then choose one of the situations from the list (for example, MMU-MARS). Follow the directions in the Description box and launch yourself into space!

Fun at the observatory You can look before you leap when you visit the observatory. View space through some of the most powerful telescopes on Earth. Because Space Simulator models the actual movements of the constellations, planets, and their moons, you can use it like a planetarium. Just choose a location, date, and time, and the observatory shows you what astronomical objects are passing over your head.

Flying start As soon as you've installed Space Simulator, you are in orbit—there's no need to bother with ground school or certification. Space Simulator is your personal gateway to the galaxy and we want to welcome you through that gate.

About the Designers

Space Simulator was created by a small, intensely dedicated team led by Charles Guy of The Bruce Artwick Organization, Ltd. (BAO). More than a decade ago, Bruce Artwick, founder of BAO, gave wings to computer users with the creation of Flight Simulator. Now, with the same meticulous dedication to realism, BAO has extended the simulator experience to space.

About the Star-Pilot's Guide

The *Microsoft Space Simulator Star-Pilot's Guide* reflects Space Simulator's sense of adventure and exploration, and it is with you every step of the journey. It becomes your copilot and instructor and guides you through trips to the Moon, the planets, and beyond, providing advice and insights along the way. The *Star-Pilot's Guide* includes all the instructions you'll need to explore the trillions upon trillions of cubic kilometers of Space Simulator's world.

The *Star-Pilot's Guide* is arranged sequentially to build your knowledge of space as you travel. If you want an overview of what's covered, the table of contents is a quick way to find out what's in store for you. To look up specific information, go directly to the index. For a handy guide to keyboard shortcuts, use the keyboard quick reference on the back cover to assist you while you fly to the Moon, take a closer look at the spacecraft, visit a space station, take a tour of the planets, record your trips, look through an observatory telescope, or embark on galactic adventures.

Conventions

Throughout the *Star-Pilot's Guide,* we use standard conventions to make your space flights easier. Here's a review of these conventions:

- A plus sign between two keys means that you press and release the two keys at the same time. For example, "To space walk, press SHIFT+W" means that you hold down the SHIFT key while pressing the W key.

Don't forget to use online Help. For more information on keyboard shortcuts, menus and commands, and basic skills, choose the topic you want from the Help menu.

- You can use both the mouse and keyboard to choose menus, commands, and dialog box options. With the mouse, simply point and click the *left* button. Standard interface terminology is used for most actions that you perform with either the mouse or the keyboard. For example, "Choose the OK button" means click the OK button, or press ENTER.
- When you choose a command name or button that is followed by an ellipsis (...), Space Simulator displays a dialog box that provides you with more information and lets you make additional choices.

For more information on navigating with the keyboard, mouse, or joystick, see Appendix A, "Using the Keyboard, Mouse, and Joystick," on page 189.

- You can use both the mouse and keyboard (as well as the joystick) for spacecraft control. With the mouse, simply click the *right* button and your mouse becomes the spacecraft control yoke. The mouse pointer disappears from your screen and you can fly by dragging the mouse left, right, forward, or backward. Press the right button again to see the mouse pointer. With the keyboard, all the keys you need for flight control are on the keyboard and numeric keypad. Keys on the numeric keypad include the LEFT ARROW, RIGHT ARROW, UP ARROW, and DOWN ARROW keys, the HOME key, the END key, or other keypad keys specified as such—for example, KEYPAD 5.
- The side columns contain tips, notes, keyboard shortcuts, illustrations, and cross-references to other information that will further your knowledge of space and piloting spacecraft.
- The glossary on page 198 provides definitions and explanations of spaceflight terminology and descriptions of astronomical objects.
- The index on page 209 is a quick way to find information. Just look up the word, concept, command, or action that you want to know more about.

Chapter 1
Installing and Starting Space Simulator

"From space I see myself as one more person among the millions and millions who lived, live, and will live on Earth. Inevitably, this makes one think about our existence and the way in which we should live to enjoy, to share, our short lives as fully as possible."—Rudolfo Neri-Vela, Mexican astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Install Space Simulator.
- Start Space Simulator.
- Choose menus, commands, and dialog box options.

This is going to be easy. The Setup program in Space Simulator does just about all the installation work for you. All you do is answer a few questions as Setup guides you through the process.

In case you want a quick review of the system requirements, we've listed them first.

System Requirements

For information on how to get the most from your system and enhance the Space Simulator experience, see "Memory" and "Performance" on pages 181 and 183.

The system requirements for Space Simulator are:

- 386/25 or higher microprocessor (486 or higher recommended)
- MS-DOS® operating system (version 5.0 or later)
- Hard drive with 15 megabytes (MB) of free disk space
- 2 MB system memory (550K free conventional memory and 768K expanded memory)
- High-density disk drive
- Video Graphics Array (VGA) card and monitor (320x400 256 colors)—Super Video Graphics Array (SVGA) card and monitor recommended

You can also enhance your spaceflight with the following:

For information on sound cards, see "Sound" on page 185.

- Microsoft Mouse or other compatible pointing device
- One joystick or a control yoke connected to an IBM-compatible game control adapter
- Sound card

Installing Space Simulator on Your Hard Disk

Your first step into the world of Space Simulator is to install it on your hard disk.

To install Space Simulator

1. Make sure your computer and monitor are turned on.

For more information, see "Setup" on page 181.

2. Insert Microsoft Space Simulator Disk 1 - Setup in drive A or drive B, and close the drive door, if necessary.
3. Change to the drive in which you inserted the Setup Disk.

   For example, if your disk is in drive A, type **a:** and then press ENTER.
4. Type **setup** and then press ENTER.

   Space Simulator starts Setup.
5. Follow the instructions on the Setup screens to install Space Simulator.

   To cancel installation at any time, press the F3 key.
6. When the installation is complete, you'll have four options to choose from:
   - If you want to start traveling through space right away, choose Launch Space Simulator.
   - If you want to exit to MS-DOS and return to Space Simulator later, choose Return to DOS.
   - If you want to read important last-minute information not found in the *Star-Pilot's Guide*, choose View the READ-ME file.
   - If you want to maximize your computer's memory configuration for Space Simulator, choose Create a Boot Disk.

Starting Space Simulator

Here's how to start Space Simulator from MS-DOS at any time.

To start Space Simulator

1. Make sure your computer and monitor are turned on.
2. Change to your Space Simulator directory.

   For example, to change to the directory on your hard disk called SPACESIM, type **cd spacesim** and then press ENTER.

3 Type **ss1** and then press ENTER.

Congratulations! You have just entered space and are orbiting Earth. Get ready to see the wonders of the galaxy from the perch of your very own spacecraft. A good first step is to take a look at Space Simulator's menus and commands so that you can find your way around without a map. The whole galaxy awaits you!

Exploring Menus and Commands

Just as Space Simulator is your personal gateway to the galaxy, the menu bar along the top of the screen is your gateway to Space Simulator. The menu bar displays five menu names—Options, Flight, Location, Window, Help—and each menu lists commands to enhance your adventures within Space Simulator.

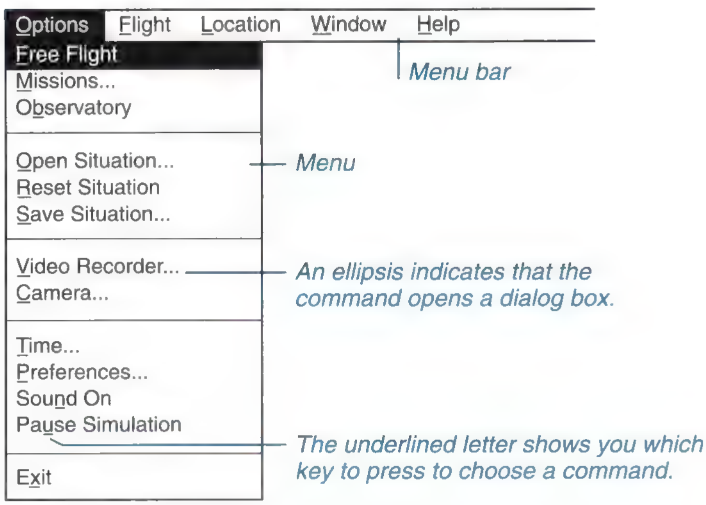
For a summary of each of the five menus and their commands, choose Menu Commands from the Help menu.

Think of the menu bar as part of your spacecraft instrument panel. Using menus and commands, you can do everything from changing your location in the galaxy to taking photographs in space.

Choosing a Command

The purpose of a menu is to gather a listing of similar commands into one place. For example, the Options menu has a listing of commands that you can use to experience space in different ways. You can fly missions, visit the observatory, or customize Space Simulator with the Preferences command.

The following illustration shows the Space Simulator menu bar with the Options menu open.



To choose a command with the keyboard

- Press ALT+ the underlined letter of the menu you want to open, and then press the underlined letter of the command you want.

  For example, press ALT+O to open the Options menu, and then press the O key to choose the Open Situation command. This is a great command to choose if you want to start flying right away. You can choose any of the situations (for example, choose MMU-MARS), follow the directions in the dialog box, and you'll be exploring space!

To choose a command with the mouse

A pointer on the screen indicates that you are in Pointer mode and you can click the left mouse button to choose menus and commands. If you can't see a pointer, you are in Yoke mode and you can use the mouse to control your spacecraft or change your view perspective. Click the right mouse button to switch between Pointer and Yoke modes.

- With the mouse pointer, click the name of the menu you want to open, and then click the command you want.

  For example, click Options on the menu bar to open the Options menu, and then click Open Situation.

To close a menu or dialog box

- Press ESC.

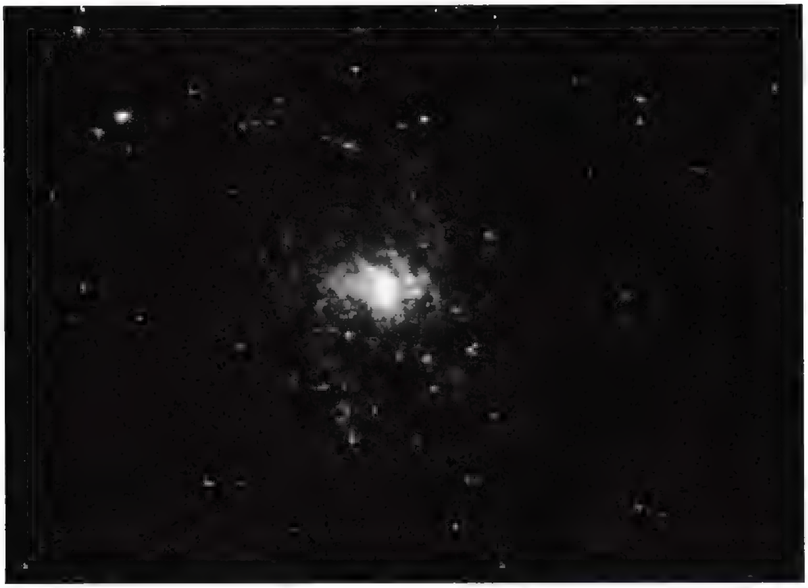
Space Simulator is designed so that you are in command of the controls—and dialog boxes increase your power and flexibility.

In the previous illustration of the Options menu, seven of the thirteen command names are followed by an ellipsis (. . .). When you choose a command followed by an ellipsis, Space Simulator displays a dialog box that lets you personalize your simulation experience. The general lesson here is: when you see a dialog box, explore what it has to offer!

Don't forget to use online Help. For more information on keyboard shortcuts, menus and commands, and basic skills, choose the topic you want from the Help menu.

As you make your way through the *Star-Pilot's Guide,* you'll put the power of these menus, commands, and dialog boxes to practical use while journeying aboard a spacecraft through the great realms of our solar system and the galaxy beyond.

Now it's time to learn about the view tools so you can view the wonders of space travel from all angles.



Leave the oceans of Earth behind you as you turn your spacecraft toward the oceans of space.

Chapter 2
Looking Out Your Spacecraft Window

"What took no analysis, however, no microscopic examination, no laborious processing, was the overwhelming beauty… the stark contrast between bright colorful home and stark black infinity."
—Russell L. Schweickart, American astronaut (from The Home Planet)

The opening situation for Space Simulator is called FLIGHT. You can also experiment with other situations and choose a new startup situation. For more information, see "Getting Yourself into Great Situations" on page 97.

In this chapter, you'll learn how to

- View space, stars, and planets with the view tools.
- Arrange different view windows.
- Control what you see in each view window.

Welcome to space!

When you start Space Simulator, you'll find yourself aboard the interstellar spacecraft, Galactic Explorer, 25,000 kilometers above the surface of the Earth, traveling at 4 kilometers per second (or 14,400 kilometers per hour) through the still and soft blackness of space.

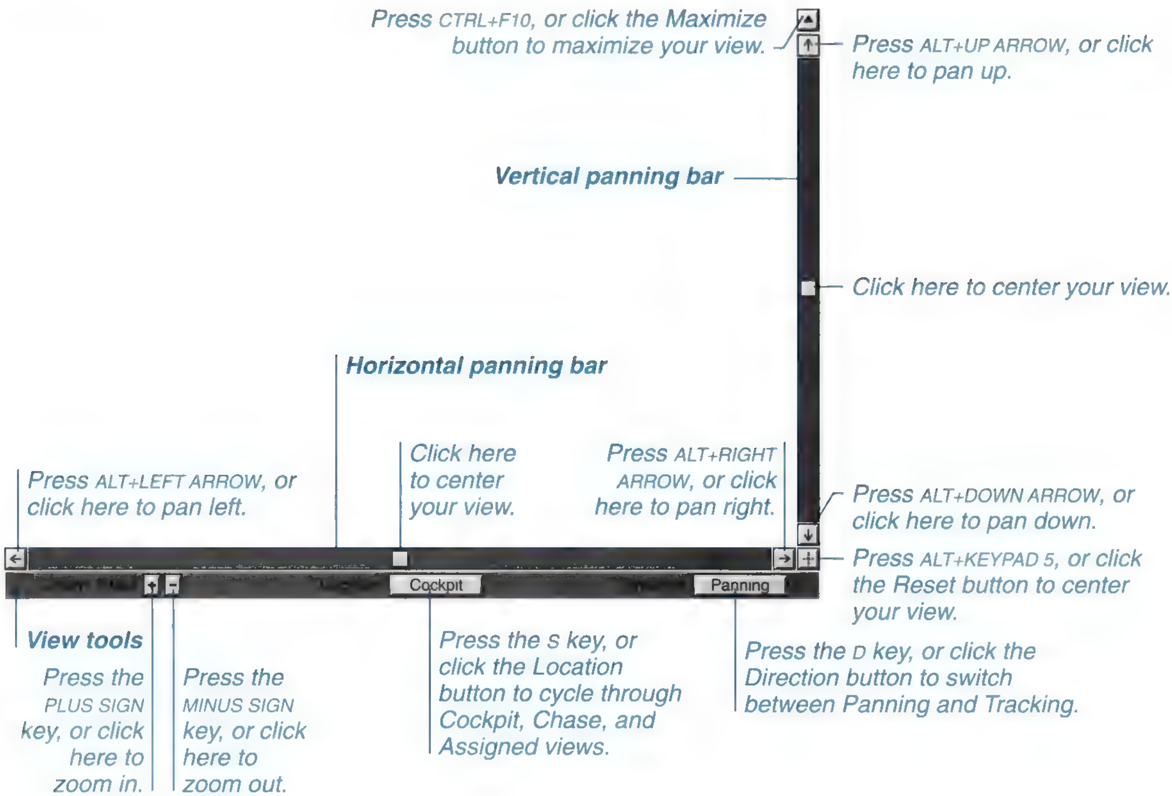
You are looking through your cockpit window. In the foreground you can see Ring Station 1 and, behind it, our wonderful home planet, looking so promising and beautiful against the unimaginable vastness of what lies beyond.

In this chapter, we'll introduce you to the powerful view tools and the Window menu so you can see and control all the sights that Space Simulator offers.

Enjoying the Views with the View Tools

All the Space Simulator spacecraft offer the possibility of 360 degrees of unobstructed viewing. When you start Space Simulator, you are looking out the front of your cockpit window with the view tools and instrument panel just below. The view tools are handy for changing your perspective and seeing all that surrounds you quickly and easily.

View Tools



For more information on View 1, View 2, and Map View, see "Arranging Views" on page 14.

For more information on Cockpit, Chase, and Assigned views, see "Changing Your View Location" on page 8.

Zooming

In space, you'll need greater powers of vision than you do here on Earth. The perspective from your spacecraft cockpit is unlike anything you're used to seeing from the driver's seat of an automobile. In Space Simulator, you can change the magnification of your view and see a readout of your current zooming power. A zoom readout of 2.00X is the normal field of vision. Space Simulator matches the human vision system so accurately that some fish-eye distortion occurs when viewing objects below a setting of 2.00X. A higher number on the zoom readout indicates increased magnification; a lower number indicates decreased magnification.

You can use the Zoom buttons in all view locations (Cockpit, Chase, and Assigned) and in all windows (View 1, View 2, and Map View). The Zoom buttons are located on the left side of the view tools, just below the main cockpit window, so that you can reach them easily while lounging in the captain's chair surveying your current domain.

Before you zoom, make sure the window you want is active. Press the 1 key (for View 1), the 2 key (for View 2), or the M key (for Map view) or click a window to make it active. The title bar of an active window is light gray; a blue title bar means a window is not active.

To zoom in or out with the keyboard

▶ Press one of the following keys or key combinations (on the keyboard, not the keypad).

+ =	*Zoom in.*
Shift + +=	*Zoom in fast.*
— -	*Zoom out.*
Shift + — -	*Zoom out fast.*
) 0	*Return to normal field of vision (2.00X).*

Hold down the mouse button while you click the Plus or Minus button, and you'll continue to zoom in or out.

To zoom in or out with the mouse

1. Choose a window.
2. On the view tools, click the Zoom buttons.
   - Click the Plus button on the view tools to zoom in.
   - Click the Minus button on the view tools to zoom out.

Watch the readout next to the buttons for changes in magnification. The normal field of vision is 2.00X. A higher number indicates increased magnification; a lower number indicates decreased magnification.

Changing Your View Location

Choose Cockpit view and you're in the pilot's seat.

Choose Chase view to see yourself flying through space from the perspective of an imaginary chase craft.

Choose Assigned view to pick whatever vantage point you want.

In the center of the view tools is the Location button, which you can choose to change your viewing location and perspective. There are three different view locations: Cockpit, Chase, and Assigned. Experiment to see how they differ.

Location	Perspective
Cockpit	Look out the cockpit window from the captain's chair and enjoy the wonders of space. Cockpit view is your perspective when you start Space Simulator for the first time.
Chase	Watch your spacecraft's every move from an imaginary chase craft tailing it at a set distance. See your spacecraft from all angles as you tour space. Use Chase view when performing precision maneuvers such as approaching a space station. You can switch back and forth between Cockpit and Chase views to perfectly position your spacecraft. For more information on setting the chase craft distance, see "Controlling Views" on page 16.

Location	Perspective
Assigned	View your spacecraft from the vantage point of your choice. For example, if you want to dock at Ring Station 1, set your Assigned view on the space station and watch yourself dock. When you start Space Simulator, the Assigned view is set on Ring Station 1 and you are looking out at your spacecraft. You can press the A key to quickly choose a new Assigned view. For more information on changing your Assigned view, see "Controlling Views" on page 16.

To choose a view with the keyboard

S *Press to cycle through Cockpit, Chase, and Assigned views.*

▶ Press the S key to cycle quickly through Cockpit, Chase, and Assigned views.

To choose a view with the mouse

▶ On the view tools, click the Location button to cycle to the view you want.

The Location button always displays the name of the current view location. Click the button once and you cycle from Cockpit to Chase view. Click it again and you cycle to Assigned view. Click it again and you return to Cockpit view.

Changing Your View Direction

Panning is like strolling around your spacecraft, looking out one window after another. Tracking is like locking your sights on just one object.

The Direction button, located on the right side of the view tools, offers two modes of viewing: panning and tracking. Panning is the initial setting when you start Space Simulator and offers panoramic vision, both horizontally and vertically. Tracking fixes your focus on a particular object and keeps it in focus throughout all your maneuvers. Each mode has its own attributes, and switching between the two enhances your viewing experience. For more information on using tracking and panning together to broaden your point of view, see "Tracking" on page 12.

To choose a mode with the keyboard

D *Press to switch between Panning and Tracking modes.*

▶ Press the D key to switch quickly between Panning and Tracking modes.

To choose a mode with the mouse

▶ On the view tools, click the Direction button to switch to the mode you want.

The Direction button always displays the name of the current mode. Click the button once and you switch from Panning to Tracking mode. Click it again and you switch back to Panning mode.

Panning

Panning is the most natural way of looking around space. It is also the most versatile. Just choose a point along one of the panning bars and your view changes, as if you were turning your head or moving to another section of the cockpit window. You get the same effect from Chase or Assigned view except that your viewing location is different.

For more information, see the illustration, "View Tools," on page 7.

Horizontal panning bar Along the base of the viewing window is the horizontal panning bar. When you move the panning box to any position between the center and either end of the horizontal bar, you are looking out the sides of your spacecraft. When you move the panning box completely to either end of the horizontal bar, you are looking directly out the back of your spacecraft.

Vertical panning bar Along the right side of the viewing window is the vertical panning bar. You can use it to change your up and down views. When you move the panning box to the top of the vertical bar, you can look straight up through the ceiling portal. When you move the panning box to the bottom of the vertical bar, you can look straight down through the floor portal.

To pan with the keyboard

Remember that your viewing direction is the direction in which you are looking, not the orientation of your spacecraft.

- Press ALT+ the arrow keys.

  For example, press ALT+LEFT ARROW to pan left, press ALT+RIGHT ARROW to pan right, press ALT+UP ARROW to pan up, and press ALT+DOWN ARROW to pan down.

  The panning box on the panning bar moves to show your viewing direction.

In Cockpit and Chase views, you can pan in eight directions quickly and easily so that you can see all around you. This viewing flexibility is called power panning.

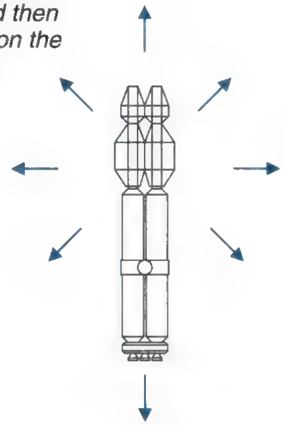
To power pan with the keyboard

- Press the following keys to power pan while in Cockpit, Chase, or Assigned view.

  The following illustrations show your viewing direction *from* the Galactic Explorer in Cockpit and Assigned views, and your view *of* the Galactic Explorer in Chase view.

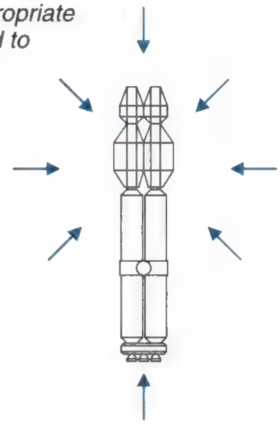
Cockpit View and Assigned View Power Panning

In Cockpit view and Assigned view, hold down the SHIFT *key and then press the appropriate keys on the numeric keypad to change panning direction.*



Chase View Power Panning

In Chase view, hold down the SHIFT *key and then press the appropriate keys on the numeric keypad to change panning direction.*



To center your view with the mouse, click the panning box in the center of the horizontal or vertical panning bar. To center both the horizontal and the vertical panning bars at the same time, click the Reset button.

To pan with the mouse

▶ Click the Arrow buttons at either end of the horizontal and vertical panning bars (for fine panning control).
–or–
Click anywhere along the panning bar.
–or–
On the panning bar, drag the panning box to the viewing direction you want.

In Cockpit, Chase, and Assigned views, you can pan in any direction so that you can see all around you. This viewing flexibility is called power panning.

To power pan with the mouse

You can also power pan with the joystick. For more information on using the Joystick, see "Using a Joystick" on page 192.

1. On the view tools, click the Location button to cycle to the view you want.

   You can power pan in Cockpit, Chase, or Assigned view.

2. On the instrument panel, click the control readout in the lower-right corner to cycle to Panning.

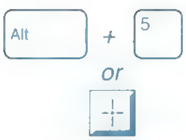
   Under Control, Space Simulator always displays the name of the current control. Click once and you cycle from Rotation to Thrust. Click again and you cycle to Panning.

3. Click the right mouse button to switch to Yoke mode.

4. Move the mouse forward, backward, left, or right to power pan in the direction you want. Click the left button at anytime to stop panning.

Resetting your view returns you to the center of the panning bar (both horizontally and vertically). Remember this if you get lost in space!

To reset both panning bars to the center



Press ALT+KEYPAD 5, or click the Reset button to center your view.

▶ With the keyboard, press ALT+KEYPAD 5.
–or–
With the mouse, click the Reset button (where the horizontal and vertical panning bars meet).

Tracking

Tracking fixes your focus on a specific object, keeping it at the center of your screen even after you have flown past it. When tracking your own spacecraft from Chase view, you continue to see your spacecraft but, as you move the panning bars, you change the direction from which you are seeing it. Try the following simple exercise in tracking your own spacecraft.

To track your spacecraft

For more information on changing your tracking object, see "Controlling Views" on page 16.

1. On the view tools, choose the Location button and cycle to Chase view.

   The Location button always displays the name of the current view location. Choose the button once and you cycle from Cockpit to Chase view. You are now viewing your spacecraft from a chase craft.

You can return to the initial view of your tracking object—straight out the front of the chase craft window—at any time by pressing ALT+KEYPAD 5 or clicking the Reset button.

2. Note that when you cycle to Chase view, the Direction button automatically switches to Tracking.

   When you use the panning bars in Tracking mode, you focus only on your spacecraft (or whatever object you choose to track). When you use the panning bars in Panning mode, you rotate your view 360 degrees to view space all around you.

3 Choose different points along the horizontal and vertical panning bars (by pressing the arrow keys or clicking the Arrow buttons on the panning bars) and see your spacecraft from different angles.

In Tracking mode, you never lose sight of the tracking object—it stays at the center of your screen.

For more information on arranging multiple windows, see "Arranging Views" on page 14.

Once you become an expert star pilot, you can track planets, moons, and stars as you fly. For example, if you are on a voyage from Mercury to Venus, you can set Venus as your tracking object.

To change your tracking object

1 Press the T key.

Space Simulator displays the Select Tracking Object dialog box.

If you want, you can assign a separate tracking object for Cockpit, Chase, and Assigned views.

2 Under Object Type, choose Planets (or any other type of object).

Space Simulator displays a list of all available planets.

3 From the list, choose Venus, and then choose the OK button.

Space Simulator returns you to spaceflight. Venus is your new tracking object. Note that Space Simulator automatically switches your viewing mode from Panning to Tracking. Your tracking object (in this case, Venus) is always at the center of your screen when you are in Tracking mode.

D *Press to switch between Panning and Tracking modes.*

You can use tracking and panning with multiple windows to broaden your point of view. For example, if you are flying to Jupiter you can use View 1 for panning and watch your flight from the safety of your spacecraft cockpit. You can use View 2 for tracking and choose the Earth as your tracking object. This way, View 2 serves as a rearview mirror—watch as the Earth recedes. On your journey, try changing the tracking object. Make it the Earth's Moon this time. Note that when you choose a tracking object, it has no effect on the direction of your spacecraft. For example, you continue traveling toward Jupiter no matter how many objects you track along the way.

Depending upon your distance from the object you are tracking, it might be just a tiny dot, or it might fill the whole screen. The handy thing to know about tracking is that, regardless of its size, the object is always at the center of your view.

Viewing the Galaxy with the Window Menu

There are so many stars, planets, moons, asteroids, and comets in Space Simulator that we created the Window menu to give you maximum control over what you see and how you see it during your voyages of exploration and wonder.

Displaying Full Screen View

To display the menu bar from Full Screen View, press the ALT key or click the top of your computer screen.

A good way to get the full impact of Space Simulator is to choose the Full Screen View command from the Window menu. Full Screen View hides your instrument panel, view tools, window titles, and menu bar. If you are looking out the front of your spacecraft cockpit, the planet Earth fills your screen. It's an awesome sight!

There are two easy ways to display Full Screen View.

To display Full Screen View

Press to turn Full Screen View on or off.

- Press the W key.
  –or–
  From the Window menu, choose Full Screen View.

  Space Simulator hides the instrument panel, view tools, window titles, and menu bar. Your computer screen becomes outer space and pulls you into a whole new realm.

To return to your original view (from Full Screen View)

- Press the W key again (you can also press the ESC key).
  –or–
  Display the menu bar first by clicking the top of your computer screen or pressing the ALT key, and then choose Menu Bar And Windows from the Window menu.

  Space Simulator returns you to your original view. The instrument panel, view tools, and view window are just where you left them.

To maximize your viewing window

Press CTRL+F10, or click the Maximize button for a larger viewing window (without the instrument panel).

Press CTRL+F5, or click the Restore button to return to the window's original size.

- Press CTRL+F10 or click the Maximize button in the upper-right corner of the screen.

  This is a modified Full Screen View. Space Simulator hides the instrument panel only. You can still use the view tools, and see window titles and the menu bar, but you have a larger window for viewing space. You can quickly display the instrument panel by pressing the I key.

Arranging Views

There are lots of ways you can view the vastness of space around you. You can use the following commands on the Window menu to display or hide different view windows, and then use the Arrange command to customize your display.

You can hide a window by pressing CTRL+F4, or clicking the Close button in the upper-left corner of the title bar.

Command	What you see
Hide View Tools	A larger viewing window. Removes the panning bars, Reset button, and the Zoom, Location, and Direction buttons. When you choose Hide View Tools, the command name changes to Show View Tools.
Hide Window Titles	Windows without title bars. Removes the title bars from across the top of the view windows. Your viewing window is larger to facilitate sightseeing through the galaxy. When you choose Hide Window Titles, the command name changes to Show Window Titles.
Show Head-Up Display	A grid and readout system overlays your viewing window—great for precision maneuvering, docking, and landing on planets, moons, and asteroids. When you choose Show Head-Up Display, the command name changes to Hide Head-Up Display.
Hide View 1	View 1 is no longer displayed. When you choose Hide View 1, the command name changes to Show View 1.
Show View 2	A second view window. Because each view window has its own set of view tools, you can set View 2 to a different viewing location, direction, and zoom magnification. When you choose Show View 2, the command name changes to Hide View 2.
Show Map View	A map view of the galaxy depicting the position of your spacecraft in relation to the nearest objects, depending on your map origin. Use Map View to track orbital changes. When you choose Show Map View, the command name changes to Hide Map View.
Hide Instrument Panel	The instrument panel disappears from view, leaving you with the view tools and more room for viewing space. You can also click the Close button to hide the instrument panel. When you choose Hide Instrument Panel, the command name changes to Show Instrument Panel.

H *Press to quickly turn the head-up display on or off.*

I *Press to display the instrument panel or make it active.*

Press to display View 1 or make it active.

Press to display View 2 or make it active.

Press to display Map View or make it active.

You can also display multiple windows at the same time for different perspectives. For example, choose View 1 and set the view location from your cockpit in Panning mode, choose View 2 and set the view location from a chase craft in Tracking mode, and then choose Map View for the overall galactic picture. You can also choose different zoom settings for each view.

To arrange views

1. From the Window menu, choose Arrange.

   Space Simulator displays the Arrange Windows dialog box.

2. Under Window Options, choose one of two options:

   - Choose Full Screen View, and the instrument panel, view tools, window titles, and menu bar disappear.

     –or–

   - Choose Menu Bar And Windows, and then choose View 1, View 2, Map View, or Instrument Panel. Choose only the view windows you want, or choose all four.

3. Under Window Preview, Space Simulator displays a preview of the window arrangement.

4. Choose the OK button to return to Space Simulator with your new window arrangement.

Controlling Views

You can use the View Controls command on the Window menu as a master control panel for many of the view functions aboard your spacecraft. If you want to change your window display, view location, and viewing direction, or pick a new tracking object and set the distance of the chase craft, you can take care of it all with convenient "one-stop shopping." The View Controls command is a comprehensive way to control every aspect of your views quickly and easily so that you can enhance the experience of flying in space.

To control your views with the View Controls command

1. From the Window menu, choose View Controls.

   Space Simulator displays the View Controls dialog box, which is divided into three sections: View Controls For Window, View Location, and View Direction.

If you choose Map View, you can also choose the objects that you want to show on the map and the map origin (it is initially at the center of your screen).

2. Under View Controls For Window, choose the view window you want: View 1, View 2, or Map View.

   Notice that the title bar changes depending on which view window you choose. For example, if you choose View 2, the title bar changes to View Controls For View 2.

3. Under View Location, choose one of three options:

You can quickly change the chase craft distance while in spaceflight by pressing ALT+PLUS SIGN *or* ALT+MINUS SIGN.

B *Press to quickly switch between relative and absolute chase craft perspectives.*

Use Assigned view as if it were a robotic video camera. Tell it where to go and it will be your eye in the sky.

T *Press to change your tracking object.*

- Choose the Cockpit option to look out the cockpit window.
- Choose the Chase Craft option to watch your spacecraft from the perspective of a chase craft, and then set the chase craft distance from your ship.

  Choose a lower number on the Chase Craft Distance scale to bring the chase craft nearer to your spacecraft. Experiment with different distances and watch what happens.

  Under Chase Craft Perspective, you can also choose the Relative option to move with the spacecraft, or the Absolute option to view your spacecraft from the standpoint of a detached observer. The Relative option is fun and exciting, but not for those prone to motion sickness!
- Choose the Assigned option to view your spacecraft or any other object from the vantage point of your choice, and then choose the Assigned View button to choose from a list of viewing places.

  Space Simulator displays the current Assigned View location directly above the Assigned View button.

  A classic use for Assigned view is to track your spacecraft from an assigned location such as a space station. But you can choose any object in Space Simulator for your Assigned view location as well as for your tracking object. For example, set your Assigned view for the Martian moon Phobos, and then set Mars as your tracking object. This way you can watch Mars orbit through space from the vantage point of Phobos.

  Choose the Docking Port Camera check box to set your Assigned view for the docking port of the space station or spacecraft that you are preparing to dock with. Watch as your ship approaches its docking port destination!

4 Under View Direction, choose one of two options:

- Choose the Panning option to rotate your view 360 degrees with the panning bar.
- Choose the Tracking option to focus on a particular object, and then choose the Tracking Object button to choose from a wide variety of objects, including stars, planets, asteroids, spacecraft, and more.

  Space Simulator displays the current Tracking Object above the Tracking Object button.

5 Choose the OK button to save your changes and return to Space Simulator.

Now that you know how to look at space from all angles, it's time to step on the gas pedal (in a manner of speaking), ease your great ship out of its current orbit, and travel to places in space that might otherwise be unavailable to you in this lifetime.

Chapter 3
First Flight

"Before I flew, I was already aware of how small and vulnerable our planet is; but only when I saw it from space, in all its ineffable beauty and fragility, did I realize that humankind's most urgent task is to cherish and preserve it for future generations."— Sigmund Jähn, German astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Use thrust to propel your spacecraft.
- Apply Newton's first law of motion to pilot your spacecraft in the vacuum of space.
- Use fine thrust for precision maneuvers.
- Steer your spacecraft by instruments (the rotation gauge and attitude display).
- Fly your spacecraft solo!

You've already learned how to change your view of space with the view tools and the Window menu. Now it's time to change your view the old-fashioned way—with the gas pedal. So take the pilot's seat and kick your huge engines into gear—but gently. You don't want to blast out of Earth's orbit yet!

And Then There's the Gas Pedal… (an Introduction to Thrust)

Thrust is the propulsive power of your spacecraft's engine. The speed, or velocity, of a spaceship is dependent upon how much thrust you apply and for how long the thrust continues. In Space Simulator, you can apply up to 4 gravities (Gs) of acceleration on most spacecraft to get places in a hurry. Some spacecraft are capable of 8 Gs but the acceleration gauge doesn't read that high.

Understanding Thrust, Acceleration, and Velocity

Now that space is your domain, let's get an idea of the three closely related principles that interact whenever you decide to go from one place to another: thrust, acceleration, and velocity.

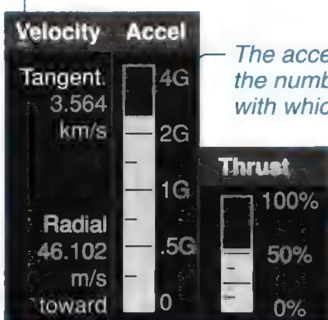
Thrust is application of force against an object to give it motion. Thrust is often measured in terms of gravity. One gravity (G) equals the thrust required to negate the gravitational force at the Earth's surface. Thrust accelerates your spacecraft to an ever greater velocity. When traveling from Earth to the Moon, you might use your thrust for five minutes. For example, an acceleration of 1 G equals 9.8 meters per second, per second (or squared). Once you cut your thrust engines, acceleration stops but the velocity remains the same until you apply reverse thrust, or until, perhaps 50,000 years later, you collide with an asteroid or some other unfortunately located object. In space travel, it is unwise to experience acceleration in excess of 3 Gs for a long period of time because of the physical force that it exerts on the human body.

Acceleration is the rate at which you change your speed. A closely related term is velocity, which is the rate at which you travel. Here's how the two work together: Assume you are traveling from Earth to the Moon. For the first five minutes of the trip your engines create an acceleration of 1 G, which equals 9.8 meters per second, per second. This means you travel 9.8 meters per second in the first second of thrust, 19.6 meters per second in the second second of thrust, and 29.4 meters per second in the third second of thrust. After five minutes at this rate of acceleration, you achieve a velocity of 2940 meters per second (10,584 kilometers or 6578 miles per hour). When you cut your thrust engines, acceleration stops but the velocity remains the same until you reverse the thrusters for the second five-minute burn to slow your spacecraft before you reach the Moon.

Press ALT+V to display a second version of the velocity gauge, which displays a total velocity readout at the top and a speed-of-light gauge at the bottom. This version of the velocity gauge is primarily used for interplanetary and interstellar passages, because the speed-of-light gauge doesn't register unless your spacecraft is traveling in excess of 5000 kilometers per second. For more information, see "Understanding the Velocity Readouts" on page 40.

Velocity is a more precise term for speed. Velocity is the rate at which an object travels from one place to another (where you are going as well as how fast, in relation to your reference object). Velocity refers to a steady rate of travel, as opposed to acceleration, which describes an increase in velocity. Within the vacuum of space, an object retains its velocity forever unless acted upon by another force.

The tangential readout displays your spacecraft's orbital velocity.



The acceleration gauge displays the number of gravities (Gs) with which you are accelerating.

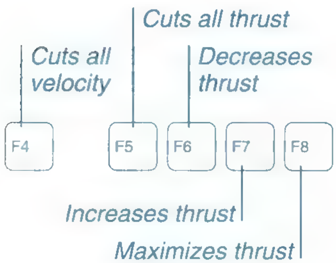
The thrust gauge displays percentage of total engine thrust potential.

The radial readout displays your spacecraft's speed toward or away from the reference object.

You can only apply thrust with the keyboard (not with the mouse or joystick). Press the PLUS SIGN and MINUS SIGN keys on the numeric keypad to increase and decrease thrust. The PLUS SIGN and MINUS SIGN keys on the main keyboard control zooming.

For more information on velocity instruments, see "Understanding the Velocity Readouts" on page 40.

The F4 through F8 keys are a handy way of controlling velocity and thrust, especially when you are flying with a joystick.



To increase thrust and accelerate your spacecraft

▶ Press KEYPAD PLUS SIGN (you can also press the END key to apply full thrust).

- The thrust gauge displays what percentage of your total engine-thrust potential you are using. It takes 32 taps of KEYPAD PLUS SIGN to achieve 100 percent thrust, which means eight taps will give you 25 percent thrust.
- The acceleration gauge displays the number of gravities with which you are accelerating. For example, when you press KEYPAD PLUS SIGN a total of eight times, the acceleration gauge shows you are accelerating at about 1 G.
- The velocity readouts update in meters per second (m/s) or kilometers per second (km/s), depending upon your velocity. Note that the readouts update even when thrust is off—for example, if your spacecraft is being gravitationally captured by a planet or other object that it is orbiting.
- The velocity gauge measures your travel in percent of C—the abbreviation for the speed of light. You have to apply thrust for a long time (or adjust the time scale) for the velocity gauge to register near light-speed.

To decrease thrust

▶ Press KEYPAD MINUS SIGN.

- The thrust gauge and the acceleration gauge respond immediately to the decrease in thrust.
- The velocity readouts show no response. When you remove thrust, a spacecraft continues at its current velocity until some other force acts to slow it down.

To immediately stop all thrust

▶ Press the HOME key.

- The thrust gauge and the acceleration gauge drop immediately to zero when you cut your engines.
- The velocity readouts show no response until you apply reverse thrust or some other force acts upon the spacecraft to slow it down.

For more information on reverse thrust, see "Newton's First Law (or Why Spacecraft Don't Have Brakes)" on page 21.

To immediately stop all velocity

▶ Press F4 (first press the HOME key to cut all thrust—otherwise your velocity immediately begins to build again).

This is a great way to immediately stop your spacecraft—remember that you stop with respect to the nearest object. If you are near a significant gravity well, your velocity increases incrementally as your spacecraft is drawn to the gravity well.

Preparing for a Close Encounter with a Space Station

For a complete and convenient guide to all the keys you'll need for flying your spacecraft, choose Keyboard Guide from the Help menu, and then choose the Flight Control Keys button.

Now that you know how to make your spacecraft go forward, let's try it out, disregarding for the moment that we haven't yet talked about how to stop or turn. Using thrust, let's take a closer look at a lunar space station.

We'll help you out by getting you to the Moon quickly and properly lining up your spacecraft with the lunar space station.

To take a closer look at a lunar space station

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose LUNAR1, and then choose the OK button.

   Space Simulator sets the scene. Your spacecraft hovers, ready to visit the lunar space station while the Moon shines in the background.

3. Press KEYPAD PLUS SIGN once.

   The thrust and acceleration gauges show that you've kicked the main engines into gear and that you are moving. Within a few seconds you'll see the space station growing larger as your spacecraft draws near.

4. Press KEYPAD MINUS SIGN once to bring the thrust-gauge reading back to zero.

   The velocity readouts, as well as your continuing approach to the lunar space station, show that reducing thrust doesn't slow you down. It stops your acceleration, but your ship retains its current velocity.

5. Hide under your desk if you can't avoid a collision with the space station.

Newton's First Law (or Why Spacecraft Don't Have Brakes)

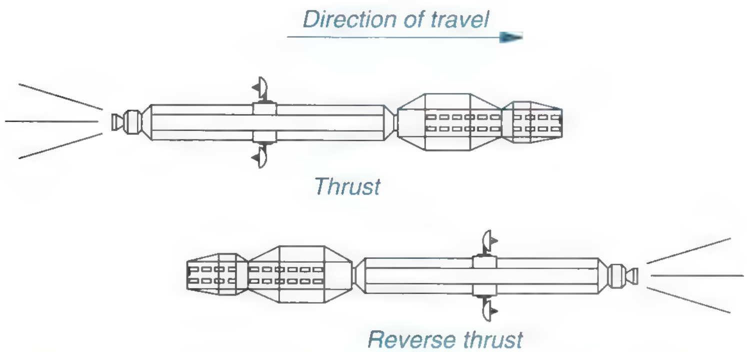
Sir Isaac Newton (1642-1727) was an English mathematician and physicist with a magnificent mind. He could visualize the motion of objects through space, while lesser minds were still trying to grasp the motion of oxcarts through mud.

Now that you've learned how to apply thrust to travel along the stellar highways, let's turn to Newton for an explanation of how to stop a spacecraft. There's more to it than just turning off the thrust. You've also got to turn your spacecraft around on its axis and apply an equal amount of thrust for an equal amount of time to offset the forces that you applied to move forward.

Applying Newton's First Law of Motion

Newton's first law of motion is "A body continues at rest or in uniform motion in a straight line unless acted upon by some force."

Within the vacuum of space, there is no friction to slow the progress of your spacecraft. If you apply thrust for one minute, and then turn the thrust off, your ship will remain in motion 10 million years from now (as long as it isn't gravitationally captured by a planet, star, or other large object).



To reverse the full thrust that comes from the main engine, you must reverse the spacecraft along its longitudinal axis, so that your engines are blasting away from your destination.

For more information on spaceflight and orbital mechanics, see "Advanced Space Piloting" on page 161.

Some day, when astronauts fly to Alpha Centauri, they will spend the first half of their journey pointing toward the star, coasting along with the velocity from their initial blast of thrust. They will spend the second half of the journey pointing back toward Earth, reversing thrust so they don't overshoot their destination.

To thrust in the reverse direction using the autopilot

The easiest way to reverse thrust is to use the autopilot to automatically rotate your craft 180 degrees. Here's how it's done.

You can also manually reverse the direction of your spacecraft. For more information, see the procedure "To play with the Moon's gravity well" on page 42.

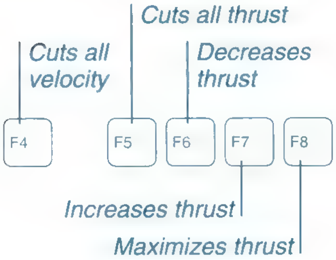
1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose LUNAR1, and then choose the OK button.

   Space Simulator positions your spacecraft close to the lunar space station with the Moon in the background.

The F4 through F8 keys are a handy way of controlling velocity and thrust, especially when you are flying with a joystick.



3. Press KEYPAD PLUS SIGN once to apply thrust.

   Watch the velocity readouts update as your velocity increases.

4. When your spacecraft reaches about 17 meters per second, press the HOME key to cut the thrust engines.

   The thrust and acceleration gauges drop to zero. The velocity readouts freeze at the current reading.

5. From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box.

6. Under Action, choose Turnover, and then choose the Execute button.

   Space Simulator turns your spacecraft 180 degrees along its longitudinal axis, reversing its direction.

7. Press KEYPAD PLUS SIGN once to apply thrust in the reverse direction.

   The thrust and acceleration gauges display an increase in the amount of thrust and acceleration.

   The velocity readouts initially decline to zero as the reverse thrust counteracts the remaining velocity. This means your spacecraft is no longer moving forward on its original (forward) course. Then the velocity readouts begin to increase again as your spacecraft accelerates on its new (reversed) course.

8. Press KEYPAD MINUS SIGN to reduce the amount of thrust.

   Watch as the thrust gauge, acceleration gauge, and velocity readouts begin to drop.

9. Press the HOME key to stop all thrust.

Congratulations! You now know how to get somewhere fast and how to slow yourself down once you get there—all without brakes!

Newton and the Fine-Thrust Gauge

Now that you know how to work the big thrust engines, let's take a look at the small ones—you can use the fine-thrust jets for precision maneuvers such as docking.

You can apply fine thrust with the mouse and joystick, as well as with the keyboard. For more information, see "Mouse Flight Controls in Yoke Mode" on page 191 or "Joystick Flight Controls" on page 193.

Newton, we hope, would have enjoyed Space Simulator immensely. And perhaps, sitting in his Cambridge study, he would have found the fine-thrust gauge on the instrument panel especially amusing (despite the fact that Newton wasn't given to light amusements). The fine-thrust gauge displays the proportion of fine thrust you're applying, as well as its forward, backward, left, right, up, or down direction.

One difference between fine thrust and rotation control is that rather than turning (yawing) your spacecraft left or right, fine thrust pushes your entire spacecraft to the left or right. And rather than pitching the nose of your spacecraft up or down, fine thrust pushes your entire spacecraft up or down.

To apply forward fine thrust

Forward fine thrust

▶ Press SHIFT+KEYPAD PLUS SIGN.

It takes 32 taps of SHIFT+KEYPAD PLUS SIGN to reach maximum forward fine thrust. Watch the fine-thrust gauge on the instrument panel to see how much forward fine thrust you've applied.

To apply backward fine thrust

Backward fine thrust

▶ Press SHIFT+KEYPAD MINUS SIGN.

It takes 32 taps of SHIFT+KEYPAD MINUS SIGN to reach maximum backward fine thrust. Watch the fine-thrust gauge on the instrument panel to see how much backward fine thrust you've applied.

To apply left fine thrust

Left fine thrust

▶ Press the INSERT key on the keypad.

It takes 32 taps of the INSERT key to reach maximum left fine thrust. Watch the fine-thrust gauge on the instrument panel to see how much left fine thrust you've applied.

To apply right fine thrust

Right fine thrust

▶ Press the DELETE key on the keypad.

It takes 32 taps of the DELETE key to reach maximum right fine thrust. Watch the fine-thrust gauge on the instrument panel to see how much right fine thrust you've applied.

To apply upward fine thrust

Upward fine thrust

▶ Press the PAGE UP key on the keypad.

It takes 32 taps of the PAGE UP key to reach maximum upward fine thrust. Watch the fine-thrust gauge on the instrument panel to see how much upward fine thrust you've applied.

To apply downward fine thrust

Downward fine thrust

▶ Press the PAGE DOWN key on the keypad.

It takes 32 taps of the PAGE DOWN key to reach maximum downward fine thrust. Watch the fine-thrust gauge on the instrument panel to see how much downward fine thrust you've applied.

To stop fine thrust

▶ Press the HOME key on the keypad.

All fine thrust is canceled and the fine-thrust gauge indicates zero fine thrust.

Playing Tag with Ring Station 1

Let's use the fine-thrust gauge to make a controlled approach to Ring Station 1. We'll begin by resetting the opening screen to get you into position.

To play tag with the space station

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose FLIGHT, and then choose the OK button.

   Space Simulator sets you up with Ring Station 1 right in front of you through your cockpit window and the Earth beyond.

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

3. On the view tools, choose the Location button and cycle to Chase view.

   The Location button always displays the name of the current view location. Choose the button once and you cycle from Cockpit to Chase view.

For information on panning or applying fine thrust with a mouse or joystick, see "Mouse Flight Controls in Yoke Mode" on page 191 or "Joystick Flight Controls" on page 193.

4 Press SHIFT+KEYPAD PLUS SIGN rapidly 15 times.

   The fine-thrust gauge incrementally registers the amount of fine thrust that you apply. It takes a while for your spacecraft to begin moving, but watch as Ring Station 1 draws near off the left side of your spacecraft.

5 Wait a minute, and then press HOME to turn off the fine thrust.

   Thrust no longer registers on the fine-thrust gauge, but, because of Newton's first law of motion, you continue to move toward the station.

6 Press SHIFT+KEYPAD MINUS SIGN rapidly 15 times.

   The fine-thrust gauge incrementally registers the amount of reverse fine thrust that you apply. Initially, your spacecraft continues toward Ring Station 1 until the reverse thrust overcomes the forward thrust and the space station recedes from view.

Now try it on your own. Use as much or as little fine thrust as you like. How close can you get? Can you make your spacecraft stand still right next to the space station? Notice that, even when your spacecraft appears to be standing still, the velocity readouts on the instrument panel show it's traveling at about 3.5 kilometers per second, or 12,600 kilometers per hour, in relation to the Earth.

Steering Your Spacecraft with the Rotation Gauge and Attitude Display

Now that you know how to accelerate and slow your spacecraft, it's time to learn how to maneuver it. The rotation gauge and attitude display on the instrument panel help you to control your spacecraft more precisely.

Using the Rotation Gauge

The blue circle of the rotation gauge is located next to the fine-thrust gauge on the instrument panel. The rotation gauge registers your spacecraft's movement. As you yaw (left or right) or pitch (nose up or down), a straight line emerges from the center of the rotation gauge, indicating the direction of your spacecraft. As you roll, a curved line emerges on the perimeter of the rotation gauge, indicating the direction of the roll. These lines grow incrementally longer as you add force to your turn or roll. The lines grow shorter as you remove force from a turn or roll. They disappear when you center your spacecraft. The rotation gauge provides excellent feedback while steering through space.

Using the Attitude Display

For more information on the reference display, see "Great Uses for the Reference Display" on page 66.

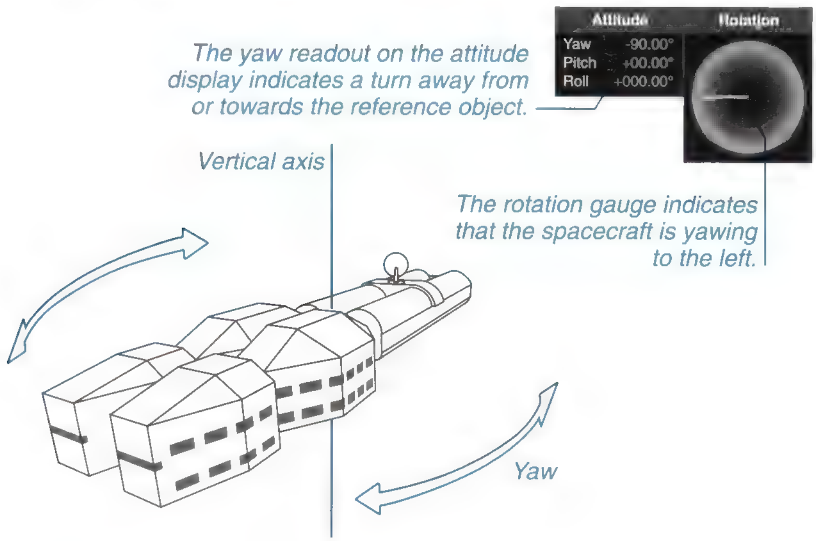
The attitude display provides a numeric reference for the rotation gauge and is a guide to your spacecraft's position relative to your selected reference object. This is important, because in space there is no up or down, and no left or right.

The attitude display shows readouts for the three key elements of flight attitude: yaw, pitch, and roll. Whereas the rotation gauge provides a relational picture of the attitude controls, the three readouts of the attitude display provide precise numerical values. Here's a closer look at yawing, pitching, and rolling.

Yawing

For information on the reference display and reference objects, see "Reading the Reference Display" on page 39.

Yawing is the sideways motion of your spacecraft about its vertical axis. Think of it as making right and left turns in space. You can yaw with the keyboard, mouse, or joystick.



To yaw your spacecraft to the left or right

For information on yawing with a mouse or joystick, see "Mouse Flight Controls in Yoke Mode" on page 191 or "Joystick Flight Controls" on page 193.

- Press the LEFT ARROW or RIGHT ARROW key to turn your spacecraft left or right.

  As you yaw, the rotation gauge shows the extent of your rotational force and the yaw readout on the attitude display registers, in degrees, your position relative to the reference object.

  The yaw readout goes from -180 to +180 degrees. A reading of 0 (zero) means you are pointing straight at your reference object (for example, Earth or the Moon). A yaw reading of -90 degrees indicates you have turned to the left 90 degrees away from the reference object. A yaw reading of +90 degrees indicates you have turned to the right 90 degrees away from the reference object.

If you fly with a mouse, you may find it easiest to stop yawing by pressing F3 (or you can click the left mouse button if you are in Yoke mode).

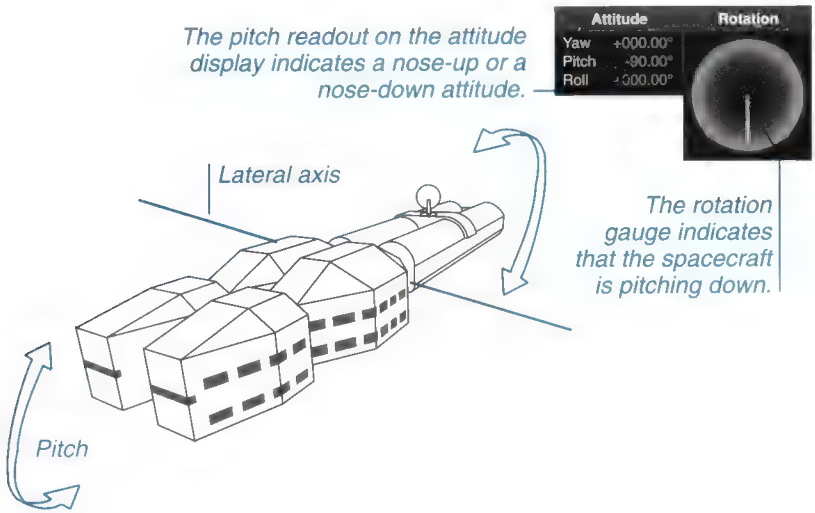
To stop yawing

- Press KEYPAD 5.

  The yaw readout shows the yaw attitude in degrees at the time you stopped yawing. Note that when you stop yawing (and center your spacecraft), your yaw attitude does not reset to zero.

Pitching

Pitching is the nose-up and nose-down motion of your spacecraft about its lateral axis. You can pitch with the keyboard, mouse, or joystick.



For information on pitching with a mouse or joystick, see "Mouse Flight Controls in Yoke Mode" on page 191 or "Joystick Flight Controls" on page 193.

To pitch your spacecraft up or down

- Press the UP ARROW or DOWN ARROW key to pitch the nose of your spacecraft up or down.

  As you point the nose of your spacecraft up or down, the rotation gauge and attitude display register the degree of climb.

  The pitch readout goes from -90 to +90 degrees. A reading of 0 (zero) means you are pointing straight at your reference object (for example, Mars or Venus). A pitch reading of -90 degrees indicates the nose of your spacecraft is pointing straight down 90 degrees away from the equatorial plane of the reference object. A pitch reading of +90 degrees indicates the nose of your spacecraft is pointing straight up 90 degrees away from the equatorial plane of the reference object.

If you fly with a mouse, you may find it easiest to stop pitching by pressing F3 (or you can click the left mouse button if you are in Yoke mode).

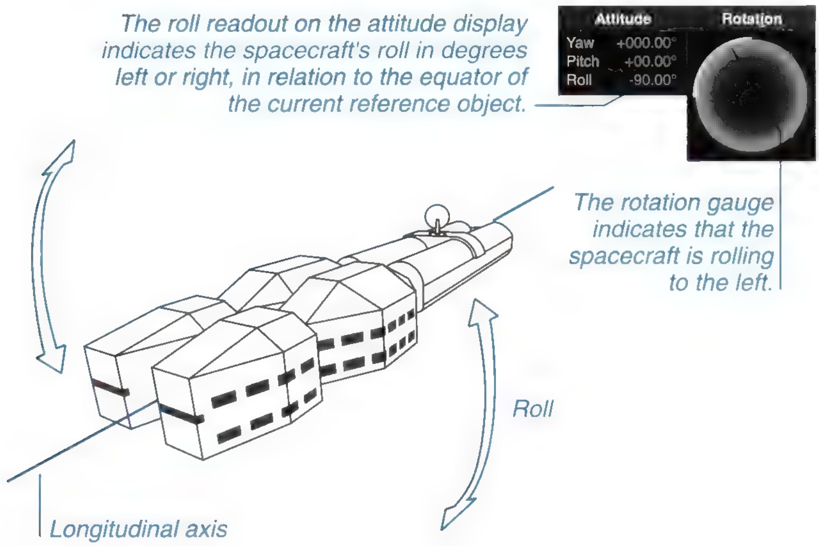
To stop pitching

▶ Press KEYPAD 5.

The pitch readout shows the pitch attitude in degrees at the time you stopped pitching. Note that when you stop pitching (and center your spacecraft), your pitch attitude does not reset to zero.

Rolling

Rolling is the banking motion of your spacecraft about its longitudinal axis—in Space Simulator, you can roll your spacecraft upside-down or onto one side and continue flying in the same direction.



You can also roll with the mouse or joystick by holding down the CTRL key while moving the mouse or joystick left or right.

To roll your spacecraft

▶ Press KEYPAD SLASH (/) to roll your spacecraft left.
–or–
Press KEYPAD ASTERISK (*) to roll your spacecraft right.

As you roll your spacecraft left and right, the rotation gauge and attitude display register the degree of roll.

The roll readout goes from -180 to +180 degrees. A roll reading of 0 (zero) means your spacecraft is aligned with the equator of the reference object.

To stop rolling

If you fly with a mouse, you may find it easiest to stop rolling by pressing F3 (or you can click the left mouse button if you are in Yoke mode).

- Press KEYPAD 5.

  The rotation gauge returns to the center position. The roll readout on the attitude display shows the roll attitude in degrees at the time you stopped rolling. Note that pressing KEYPAD 5 does not reset your roll attitude to zero.

Taking a Spin Around Ring Station 1

Now let's combine your acceleration and steering skills with your knowledge of the rotation gauge and attitude display to take a quick spin around Ring Station 1. Please drive carefully! Fender-benders in space tend to have more drastic consequences than they do on Earth.

To take a quick spin around the space station

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose FLIGHT, and then choose the OK button.

   Space Simulator sets you up with Ring Station 1 right in front of you through your cockpit window and the Earth beyond.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

3. On the view tools, choose the Location button and cycle to Chase view.

   The Location button always displays the name of the current view location. Choose the button once and you cycle from Cockpit to Chase view. In Chase view, you see your spacecraft in front of you (from the perspective of a chase craft).

4. Pan slightly to the left by pressing ALT+LEFT ARROW or clicking the horizontal panning bar until you have Ring Station 1 and the Earth in view beyond your spacecraft.

For information on controlling your spacecraft with a mouse or joystick, see "Mouse Flight Controls in Yoke Mode" on page 191 or "Joystick Flight Controls" on page 193.

5. Press SHIFT+KEYPAD PLUS to apply forward fine thrust.

6. Press the arrow keys (or use the mouse or joystick) for yaw and pitch.

   Watch the rotation gauge and attitude display as you make your journey around the space station. If you get close enough, it's okay to wave. But remember that in space, you don't roll down the windows.

Seat-of-the-Pants Piloting with the Attitude Display

Brave star pilots who want to have fun without relying on the autopilot can try their skills at seat-of-the-pants piloting using the yaw and pitch readouts on the attitude display.

For information on the autopilot, see "Flying with the Autopilot" on page 105.

To steer by the attitude display, just choose a reference object, and then steer a course to keep both yaw and pitch as close to zero as possible. In this manner, you can fly the 384,326 kilometers (238,860 miles) to Earth's Moon, the 778,273,000 kilometers (483,700,000 miles) to Jupiter,

or the 5,964,209,020 kilometers (3,706,780,000 miles) to Pluto. For longer flights, even the hard-core romantic might want to consider the benefits of an autopilot and a flight computer.

For the fun of it, we'll set a course for our nearest planetary neighbor, Venus. Make sure you set aside a block of time, and pack a lunch—this trip will take a while.

To fly to Venus using the attitude display

1 From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2 From the File Name list, choose TOVENUS, and then choose the OK button.

   Space Simulator sets you up with your spacecraft in front of you and the planet Venus in the distance.

For information on labels, see "Choosing Label Preferences" on page 61.

3 Press the L key.

   Space Simulator turns the labels feature on so that you can see exactly where Venus is in the sky. To turn labels off, just press the L key again.

4 Check the reference display on the instrument panel.

   Space Simulator indicates that Venus is your reference object and displays its distance from your spacecraft in kilometers.

5 Notice that your spacecraft is not pointing toward Venus.

   The attitude display also reflects this offset. The yaw, pitch, and roll readouts are at or near zero only when you are pointing precisely at your current reference object—in this case, Venus.

6 Apply full thrust by pressing KEYPAD PLUS SIGN until you reach 100 percent.

For information on pitching and yawing with a mouse or joystick, see "Mouse Flight Controls in Yoke Mode" on page 191 or "Joystick Flight Controls" on page 193.

7 Press the RIGHT ARROW key to yaw your spacecraft to the right until Venus is horizontally centered on your screen and the yaw readout on the instrument panel nears zero.

   Because Venus is your current reference object, the yaw readout uses Venus as the zero or centered reading.

8 Press KEYPAD 5 to stop yawing.

9 Press the DOWN ARROW key to pitch your spacecraft until Venus is vertically centered on your screen and the pitch readout on the instrument panel nears zero.

   Because Venus is your current reference object, the pitch readout uses Venus as the zero or centered reading.

10 Press KEYPAD 5 to stop pitching.

11 Press KEYPAD SLASH (/) to roll your spacecraft to the left until you align it with the equator of the planet Venus.

   As your spacecraft aligns with the equator of Venus, the roll readout nears zero.

12 Continue your journey to Venus, using the keyboard, mouse, or joystick to keep the yaw, pitch, and roll readouts at or near zero.

   During the voyage to Venus you'll need to make these adjustments to compensate for the movement of Venus as it orbits around the Sun.

For information on how to speed up your voyage, see the procedure "To change the time scale" on page 36.

At 4 Gs of acceleration, depending on where Earth and Venus are in their orbital tracks, and assuming you are decelerating for a landing on the second half of your trip, you should arrive in anywhere from 18 to 36 hours.

Spacecraft less hearty and less fuel-efficient than yours would probably coast most of the way, turning the trip to Venus into a months-long event. You can give this a try by accelerating at 1 G for two hours, and then letting your engines rest until you are two hours away from Venus, a few years from now. Just remember to check your attitude display every now and then, and to keep the readouts zeroed in on Venus.

Congratulations! You now know how to apply Newtonian physics to spacecraft flight—no small feat! In the next chapter, you'll learn how to travel faster than the speed of light.

Chapter 4
We're Off to the Moon!

"Under a full moon the clouds are luminous in pearly reflection. The high-altitude atmospheric airglow appears on the horizon as a stunning bronze-colored band above the now dark air."—Charles Walker, American astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Get places quickly with the Location menu.
- Speed or slow the passage of time with the time scale.
- Change your chase craft view.
- Monitor your orbit on the instrument panel.
- Play with gravity wells.
- Land on the Moon.

For more information on flying to the Moon using the autopilot, see "Advanced Space Piloting" on page 161.

For as long as humans have been able to look upward and wonder, the Moon has held a great fascination, first weaving its way into our folklore and mythology, and then into our early space program.

Let's take off to the Moon for our next flying session and get there fast using the Location menu.

Using the Location Menu to Exceed the Speed of Light

The Location menu lets you exceed the speed of light. With just a few keystrokes or clicks of the mouse, you can transfer yourself from Earth to the Moon, Saturn, Jupiter, Pluto, or any number of other moons, planets, or stars. The Location menu puts you within perfect viewing distance. Let's make a trial run to see a galaxy that is far, far away, and then we'll visit the Moon.

To visit the Andromeda Galaxy with the Location menu

1. From the Location menu, choose Deep Sky.

   Space Simulator displays the Deep Sky Objects dialog box.

Whenever you choose an object from the Location menu, you can also get information on its scientific background, size, and distance.

2. From the list, choose Andromeda Galaxy.

   Space Simulator displays information about the Andromeda Galaxy in the Description box.

3. Note that under Update, Space Simulator displays two check boxes: Reference Object and Tracking Object.

For more information on the reference display, see "Great Uses for the Reference Display" on page 66.

- When you check the Reference Object box, Space Simulator updates the reference display on the instrument panel to show the current reference object, as well as your distance from it. For example, when you start Space Simulator, the reference object is Earth. But if you choose Andromeda Galaxy from the Location menu, Andromeda becomes your new reference object and the distance display shows how far your spacecraft is from it.
- When you check the Tracking Object box, Space Simulator updates the tracking object to your new location. For example, if you choose Andromeda Galaxy from the Location menu, and then choose the Direction button on the view tools and cycle to Tracking, you will be tracking the Andromeda Galaxy.
- You can also choose not to update your reference object or tracking object. For example, if you change your location from Earth to the Moon and you want to see how far you are from Earth or track the Earth from lunar orbit—uncheck these check boxes.

4 Choose the OK button.

Presto! You've just traveled more than a million light-years through space. You've still got another 727,231 light-years to go, but Andromeda already appears as a brilliant glow in the dark sky.

To zoom in for a closer look at the Andromeda Galaxy, press the PLUS SIGN key on the keyboard several times or click the Plus button on the view tools.

With the Location menu, you can transport yourself and your spacecraft across the vast reaches of space in the blink of an eye. It might be centuries before real spacecraft have such a powerful instrument. Besides deep space objects, you can choose from stars, planets, moons, comets, asteroids, space stations, spacecraft, and surface locations, and get helpful information on each. But our destination now is Earth's Moon, so let's head there.

If you don't see Earth's Moon in the Moons dialog box, it's because you are outside of our solar system. Choose Open Situation from the Options menu, and choose FLIGHT from the list. Now choose Moons from the Location menu, and you'll see Earth's Moon in the list.

To visit the Moon with the Location menu

1 From the Location menu, choose Moons.

Space Simulator displays the Moons dialog box.

2 From the list choose Earth's Moon, and then choose the OK button.

Space Simulator displays information about the Moon in the Description box.

3 Choose the OK button.

Welcome! You are now in a stable orbit around the Moon.

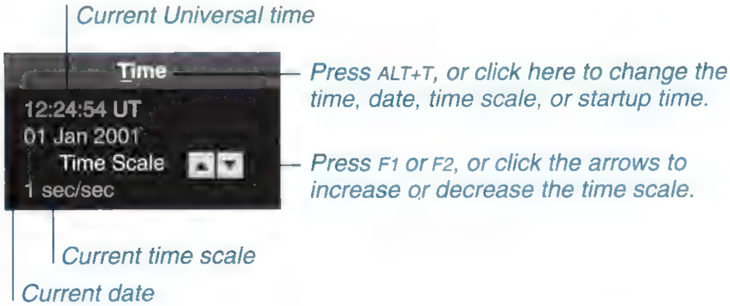
Playing with Time

The time display in the lower-left corner of the instrument panel does away with the drudgery of time, which in space (even more than on Earth) always seems to be working against short-lived humans. You can change the date or time, as well as accelerate or decelerate the passage of time.

In Space Simulator, time is expressed in Universal time, which is the standard measurement of time used on Earth and in astronomy, and is also

known as Greenwich mean time. It's a measurement based on the passage of the sun over zero longitude, or the prime meridian, that passes through the Royal Observatory in Greenwich, England.

To calculate Universal time, first convert standard time to military time (for example, 4:00 PM becomes 1600 H), and then add 5 hours to standard time if you live in New York City, add 8 hours if you live in Los Angeles, subtract 1 hour if you live in Berlin, and subtract 9 hours if you live in Tokyo. If you live in Paris or London, standard time is the same as Universal time.



The realism of Space Simulator is so complete that when you arrive at a new location (for example, the Moon) on a particular date and time, you experience the exact lighting conditions you would find if you arrived there in a real spacecraft. When you find yourself on the dark side, you can play with time so that the Moon is in a better orbital position for being illuminated by the Sun. You can change the day of the month, the month, or even the year until you find the ideal lighting conditions for your exploration.

To set the time or date

You can quickly display the Time dialog box by pressing ALT+T or clicking the time display on the instrument panel.

1. From the Options menu, choose Time.
   –or–
   Click the time display on the instrument panel.

   Space Simulator displays the Time dialog box.
2. In the Time box, type the time you want in Universal time.
3. In the Date box, type the date you want.

   Make sure that you type the new date in the format of day, month (abbreviated to the first three letters), and year. For example, type **01 Jan 2100**.
4. You can also choose whether or not to start up Space Simulator using system time or situation time.
   - Choose Use System Time if you want Space Simulator's time display to match your computer's time (converted to Universal time).
   - Choose Use Situation Time if you want Space Simulator's time to match the currently assigned startup situation. If you open another situation, the time and date are changed to the time and date that you saved with the situation.

5 Choose the OK button and return to Space Simulator.

Space Simulator displays the new time and date on the time display.

To put your spacecraft into orbit around Earth's Moon, see the procedure "To visit the Moon with the Location menu" on page 34.

Now have some fun—try accelerating your revolutions around the Moon. Set the time scale at 8.5 minutes per second so you can see your spacecraft's motion as you orbit. Make sure the Direction button is set for tracking rather than panning if you want to keep the Moon constantly in view.

To change the time scale

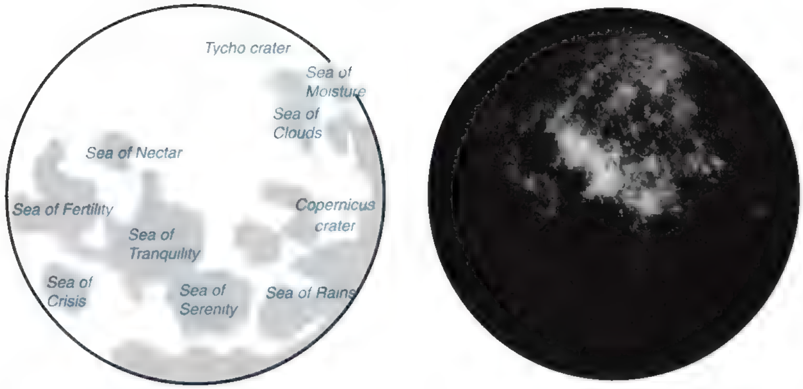
You can also increase or decrease the time scale by choosing Time from the Options menu, and then choosing the Double button or Halve button in the Time dialog box.

- Press the F1 key or the F2 key to increase or decrease the passage of time (press SHIFT+F1 to increase to 1.1 years/sec or press SHIFT+F2 to return to the initial 1 sec/sec).
  –or–
  On the time scale in the lower-left corner of the instrument panel, click the up arrow or the down arrow to increase or decrease the passage of time.

  You double the passage of time or halve the passage of time with each keystroke or each click of the mouse. The time scale ranges from its slowest setting of 0.001 seconds per second to 8710.5 years per second. Space Simulator displays your changes on the instrument panel. Note that if you accelerate the passage of time too much—for example, to years per second—you'll find yourself blasting out of orbit. Also note that orbital maneuvers are more accurate when the time scale is at a lower rather than a higher setting.

W *Press to turn Full Screen View on or off.*

Now that you've arrived in lunar orbit, you might want to note some lunar landmarks so you can check your progress while you orbit. Take a look at the lunar maps on the next page and familiarize yourself with the geography of the Moon—or at least the side that we always see from Earth. For example, can you find the Sea of Serenity (Mare Serenitatis) flowing into the Sea of Tranquillity (Mare Tranquillitatis), and the Sea of Crises (Mare Crisium) set off by itself? If you don't see them this revolution, perhaps you'll see them the next time around.



Prominent features on the Moon

Changing Your Chase Craft View

If you increased the passage of time using the time scale on the instrument panel, reduce it to just a few seconds per second before changing to Chase view. This gives you time to orient your spacecraft with the Moon as a backdrop, without worrying about temporarily losing sight of the Moon as it hurtles along on an accelerated orbit. Once you switch to Chase view, you can speed up the passage of time again.

While orbiting the Moon, a good way to understand where you and your spacecraft are in the scheme of things is to switch from Cockpit to Chase view. Once you've got the big picture, you can also change your chase craft view location to see your spacecraft from a different perspective.

To change your chase craft view location

1. From the Window menu, choose Hide Instrument Panel.

   Space Simulator hides the instrument panel and expands View 1, leaving you with the view tools.

2. On the view tools, choose the Location button to cycle to Chase view.

   Your spacecraft appears in the foreground with the Moon beyond.

3. Use the horizontal panning bar to shift your chase craft view location to the left or right.

4. Use the vertical panning bars to shift your chase craft view up or down.

Now that you know how to change the chase craft perspective, let's change the chase craft's distance from your spacecraft with the shortcut keys. This way, you can quickly move the chase craft closer to or farther away from your spacecraft, but the Moon remains the same size. The effect of a small ship orbiting a large Moon can be very pleasing.

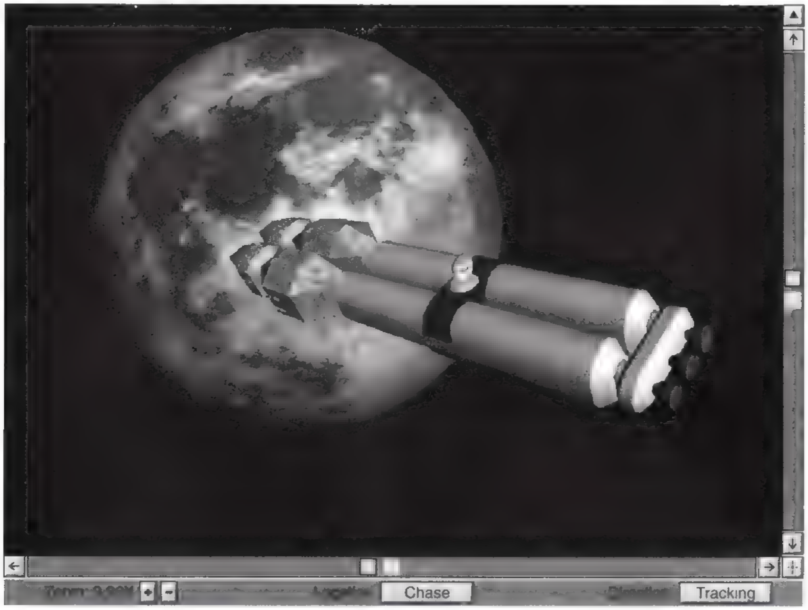
To quickly change the chase craft distance

When using ALT+MINUS SIGN and ALT+PLUS SIGN, be sure to use the PLUS SIGN and MINUS SIGN on the main keyboard, not on the numeric keypad.

▶ Press ALT+MINUS SIGN or ALT+PLUS SIGN to decrease or increase the distance of the chase craft.

Watch as your spacecraft gets closer to or farther away from the chase craft that is tracking its every move.

You can also change the chase craft distance by choosing View Controls from the Window menu. For more information, see "Controlling Views" on page 16.



Chase view of the Galactic Explorer interstellar spacecraft approaching Earth's Moon.

If you lose sight of the Moon while in Chase view, here are some tips for getting it back into sight.

To find the Moon—if you lose track of it

1. On the view tools, choose the Location button to cycle from Chase to Cockpit view.

   You are now looking out the front window of your cockpit.

2. On the view tools, choose the Direction button to switch from Panning to Tracking mode.
3. To choose the Moon as your tracking object, press the T key.

   Space Simulator displays the Select Tracking Object dialog box.

4. Under Object Type, choose Moons.
5. From the list, choose Earth's Moon, and then choose the OK button.

   The Moon is now in the center of your viewing window.

6. From the Window menu, choose Show Instrument Panel or press the I key.

To make sure you have the Moon in sight, press the L key to see labels.

If you need to reset the reference object, press ALT+R or click the reference display on the instrument panel, choose Moons, and then choose Earth's Moon from the list.

Space Simulator displays the instrument panel.

7 On the instrument panel, under Reference, verify that the Earth's Moon is your current reference object.

Notice the distance of the Moon from your spacecraft or, if you press ALT+S, notice the measurement expressed in radii and in altitude from the surface of the Moon.

Monitoring Your Orbit from the Instrument Panel

The views from space are magnificent and that's much of the reason for going. However, don't get too distracted. The realism of Space Simulator is such that everything is in motion, and everything is susceptible to gravitational pull. For this reason, you have to keep an eye on your instruments, too. Two excellent instruments for staying on top of your orbital status are the distance readout on the reference display and the velocity readouts.

Reading the Reference Display

The reference display on the instrument panel displays the current reference object—in this case Earth's Moon—and your distance from it. The distance readout is helpful while traveling either to or from the Moon. Once in orbit around it, you may want information on the radius and altitude as well.

Current reference object

Press ALT+R, or click here to choose a reference object.

Press ALT+S, or click here to display your spacecraft's distance from the reference object in radiuses, or radii, and your spacecraft's altitude above the surface.

Distance from the reference object in kilometers

Let's take a closer look at the three types of measurements provided by the reference display:

The initial readout on the reference display shows distance. Radius and altitude information are not available until your spacecraft is within 99,999 kilometers (altitude) of the reference object.

Distance The distance readout provides the measurement from the center of your spacecraft to the center of the reference object. For example, if the distance readout shows 1739 kilometers, it may seem like a lot until you remember that the radius of the Moon is 1738 kilometers, meaning you are only one kilometer above the surface and probably destined to crash.

Radius The radius readout shows the number of radii your spacecraft is from the reference object. A radius is equal to one-half the diameter of an object, so a radius reading of 1 is the distance from the center of the object to its surface, which means that you have landed. The radius measurement

is convenient for visualizing your distance from an object when you are still a long way away.

Altitude The altitude readout provides your height above the surface of the reference object. This is probably the best readout to use when maneuvering near the surface of the Moon or any other object.

For more information on changing the time scale, see "Playing with Time" on page 34.

Note that unless you happen to be in an absolutely perfect circular orbit, your altitude readout is constantly changing. However, if the time scale is set for less than 16 seconds per second, the slow passage of time won't make the altitude readout very exciting to watch.

To change the reference display information

For more information on the reference display, see "Great Uses for the Reference Display" on page 66.

1. Press ALT+R or click *on* the reference object name to change to a different reference object.

   Space Simulator displays the Select Reference Object dialog box and you can choose from a variety of reference objects (for example, any of the stars, planets, comets, space stations, and so on).

2. Press ALT+S or click *below* the reference object on the instrument panel to cycle between the distance readout and the radius and altitude readouts.

Understanding the Velocity Readouts

Space Simulator provides three different sets of velocity readouts. In each case, the velocity readouts show the speed at which you are traveling through space in relation to the reference object. Long after you turn off all thrusters, your velocity continues to fluctuate if you are in orbit.

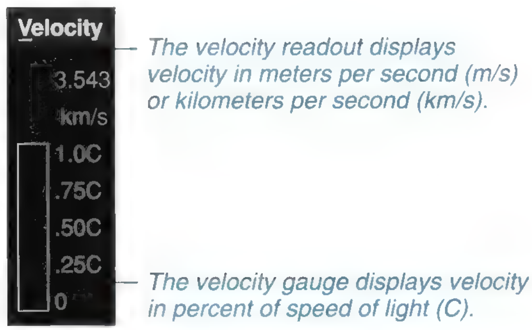
To change the velocity readout information

▶ Press ALT+V or click the velocity gauge to change velocity information.

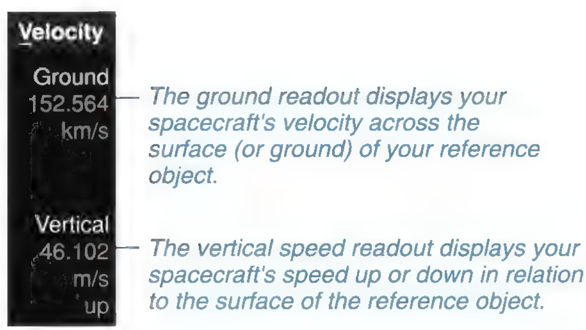
Space Simulator switches between velocity readouts.

Tangential and radial velocity The tangential velocity readout displays your spacecraft's velocity incidental (or tangential) to the reference object. The radial velocity readout displays your spacecraft's velocity in direct relation to the reference object. With radial velocity, you are either going toward or away from your reference object. Both tangential and radial velocity readouts are most useful when you update the reference object for either your destination or point of departure. For example, if you are flying from Neptune to Pluto, make your reference object one of those two mysterious planets.

Total velocity and the speed-of-light gauge The total velocity readout displays your spacecraft's velocity. The speed-of-light gauge displays velocity in percentage of speed of light. It is primarily used for interplanetary and interstellar passages, because speed of light doesn't register unless your spacecraft is traveling in excess of 5000 kilometers per second.



Ground velocity and vertical speed Space Simulator automatically displays the ground velocity and vertical speed readouts in place of the tangential and radial velocity readouts whenever your spacecraft is within 1.01 radii of the surface of your reference object. For example, when you are taking off from Cape Canaveral, Space Simulator displays the ground velocity and vertical speed readouts until your spacecraft exceeds an altitude of about 60 kilometers, and then it displays the tangential and radial velocity readouts.



For more information on the relationship between altitude and velocity, see "Advanced Space Piloting" on page 161.

By watching the altitude and velocity readouts on the instrument panel, you can see the math of orbital mechanics unfolding before your eyes. As the altitude increases, which is to say the distance away from the Moon, the velocity decreases. You can watch the altitude reach its highest point and then begin to lower, at which point the velocity begins to increase. The more eccentric, or elliptical, your orbit is, the greater the difference in the altitude, and the greater the difference in velocity as your spacecraft travels from the farthest to the nearest points of its orbit. This ever-changing relationship between altitude and velocity can be enjoyable and intriguing to watch.

Playing with Gravity Wells

The term gravity well refers to the gravitational pull that a mass, such as a sun, planet, or moon, exerts. For example, if you are sitting on a launch pad on Earth, ready to blast into space, your rocket engines need to generate sufficient thrust for you to climb out of the Earth's gravity well and achieve a stable orbit.

In real life gravity is always playing with us—knocking over books, allowing trees to fall in wind storms, and making it hard to ride a bicycle uphill. Now that you have your own spacecraft, you can play with gravity, but you have to be a little bit daring, and you have to keep a sharp eye on your instrument panel.

Let's try playing with the Moon's gravity well. First we'll blast our spacecraft toward the Moon, and then turn the spacecraft around so that its great engines thrust in the reverse direction and slow our descent. We'll dip deep into the Moon's gravity well before climbing back out.

To play with the Moon's gravity well

1. From the Location menu, choose Moons.

   Space Simulator displays the Moons dialog box.

2. From the list, choose Earth's Moon.

   Space Simulator places your spacecraft in a stable orbit around the Moon, at a distance of 6952 kilometers.

For more information on changing the time scale, see "Playing with Time" on page 34.

3. To change the reference display from distance to altitude, press ALT+S or click below the reference object on the instrument panel.

   The altitude readout displays your elevation above the surface of the Moon, which is what you need to know when coming in for a landing. The distance readout displays your distance from the Moon's core.

4. Make sure that the time scale is at 1 second per second (press SHIFT+F2).

   If you keep the time scale at true time (1 sec/sec) or only modestly advanced, you'll have more time to prepare for your landing.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

5. Choose the Location button to cycle from Cockpit to Chase view to see your spacecraft and its relationship to the Moon, and then adjust your view by increasing the distance of the chase craft (press ALT+MINUS SIGN) or by panning to the left or right.

6. Press F4 to cancel all orbital velocity.

   The velocity readouts drop to zero, and then begin to climb because of gravity.

7 Press KEYPAD PLUS SIGN until you reach full acceleration (check the acceleration gauge).

This will blast you toward the Moon.

8 Watch the radial velocity readout and, when it displays 4 km/s, press HOME to cut thrust.

Watch as your spacecraft descends toward the lunar surface.

9 Descend to an altitude of 4000 kilometers, and then use either the RIGHT ARROW or LEFT ARROW key to yaw your ship 180 degrees.

For more information on maneuvering your spacecraft, see "Steering Your Spacecraft with the Rotation Gauge and Attitude Display" on page 26.

10 When the yaw readout on the instrument panel reaches either plus or minus 180 degrees (give or take a degree), press KEYPAD 5 to stop turning.

Now you are approaching the Moon with the back of your spacecraft so you can exert full thrust to slow your descent.

11 Press SHIFT+KEYPAD 8 or click either end of the horizontal panning bar to see a head-on chase craft view of your spacecraft with the Moon in the background.

12 Press F1 to double the passage of time or press F2 to halve the passage of time.

Use the time scale to speed or slow the simulation to your liking. A rate of about 4 seconds per second works well.

Sit back and enjoy the show, but keep an eye on the instrument panel and notice that as your altitude decreases, your velocity increases. The Moon's gravitational pull is drawing you in. The nearer you get, the faster your spacecraft accelerates toward it.

13 When the altitude readout drops to 3000 kilometers, press KEYPAD PLUS SIGN twice.

Watch as the radial velocity begins to decrease.

14 When your altitude drops to 2000 kilometers, press KEYPAD PLUS SIGN twice more.

Your radial velocity continues to decrease but your spacecraft keeps descending toward the Moon.

15 When your altitude drops to 1000 kilometers, once again press KEYPAD PLUS SIGN twice.

This makes a total of six times that you press KEYPAD PLUS SIGN, and brings the acceleration readout to almost 1 G.

When the thrust of your spacecraft overcomes the gravitational pull of the Moon, the radial velocity readout changes from TOWARD to AWAY.

16 Continue to descend until you reach an altitude between 600 and 700 kilometers above the surface, at which point the thrust of your spacecraft finally conquers the gravitational pull of the Moon.

Watch your altitude and velocity readouts for the transition—your altitude and velocity increase as your spacecraft starts moving away from the Moon.

Landing on the Moon

Now that you've survived a close encounter with the Moon's gravity, let's go a step further. This could be a historic occasion for you. Follow the procedure below and land your spacecraft on the Moon. For this landing, we'll consider any touchdown with a velocity of less than 500 meters per second a success. So, here goes!

To land on the Moon

1 From the Flight menu, choose Spacecraft.

Space Simulator displays the Spacecraft dialog box.

2 From the list of spacecraft, choose the All Terrain Lander.

Because of its horizontal hovering capabilities, the ATL is a great spacecraft for practicing landings on the Moon.

Press ALT+S or click below the reference object on the instrument panel to switch between distance and altitude readouts. The distance readout displays your distance from the Moon's core. The altitude readout displays your elevation above the surface of the Moon, which is what you need to know when coming in for a landing.

3 Follow steps 1 through 14 from the previous procedure, to place yourself in a lunar descent (2000 kilometers above the surface) with your engines thrusting in the reverse direction to brake your speed.

4 When your spacecraft descends to an altitude of 500 kilometers above the surface, press KEYPAD PLUS SIGN four more times.

This additional thrust helps to counteract the increasing gravitational pull of the Moon.

5 Monitor the altitude and radial velocity readouts and, as soon as you stop losing altitude and your radial velocity drops almost to 0 (zero) meters per second, press the HOME key to cut all thrust.

If you don't press HOME at 0 meters per second, the radial velocity switches from TOWARD to AWAY. You'll be able to counteract this upward velocity later in the landing.

For more information on maneuvering your spacecraft, see "Steering Your Spacecraft with the Rotation Gauge and Attitude Display" on page 26.

6 Maneuver the ATL into a position horizontal with the Moon's surface to prepare for landing.

Your spacecraft is horizontal with the lunar surface when your pitch readout displays +90 degrees. The ATL has powerful thrusters that make it a good spacecraft for horizontal hovering in takeoffs and landings.

7 Monitor the radial velocity readout as it increases in the TOWARD direction.

If your radial velocity is still registering in the AWAY direction, press the PAGE DOWN key to cancel the outbound velocity, bringing radial velocity back to zero.

8 When the radial velocity readout climbs to 500 meters per second, press the PAGE UP key six or seven times until the radial velocity begins to decrease.

9 If the radial velocity readout drops to less than 100 meters per second, press HOME to cancel all fine thrust.

The Moon's gravity continues to pull you toward the lunar surface.

For information on launching your spacecraft from the Moon and flying to new destinations, see "Flying with the Autopilot" on page 105.

10 Press the G key to extend the landing pads.

11 During the last 5 kilometers of descent, use the PAGE UP and HOME keys to bring your vertical velocity to as close to zero as possible.

   Consider it a good landing if your vertical velocity is below 500 meters per second, but consider it a great landing if your vertical velocity is below 10 meters per second upon impact. The altitude readout displays "Landed" when you're on the surface of the Moon.

Welcome to the Moon. "That's one small step for space simulation, and one giant step for mankind."

In the grasp of gravity, the all terrain lander is pulled toward the Moon. Apply upward thrust to slow its descent for a landing.

Chapter 5
Slewing Through Space

"When you look out the other way toward the stars you realize it's an awful long way to the next watering hole."—Loren Acton, American astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Defy the laws of physics with the Slew Control command.
- Make space travel easier.

For more information on using the time scale, see "Playing with Time" on page 34.

Your antigravity machine has just arrived! You are no longer bound by the laws of physics! Welcome to the world of slewing, one of the most powerful tools that Space Simulator offers, perhaps only second to the time scale (which, as you've already seen, is much like having your own time machine). Think of slew control as your very own antigravity machine.

At Last, Freedom from Gravity and from Newton, Too!

Space Simulator is so realistic—with every object exerting complete gravitational force, and with every star, planet, moon, and other body gliding through space in proper motion—that we created a special switch that lets you bypass the laws of physics and pilot your spacecraft without having to worry about the mechanics of flying in space. This switch, found on the Flight menu, is the Slew Control command.

For more information on gravity and momentum, see "Newton's First Law (or Why Spacecraft Don't Have Brakes)" on page 21.

Slew control frees you not only from the gravitational attraction of large bodies, but from the conservation of momentum described by Newton's first law of motion. In short, this means you no longer need to worry about reversing thrust and decelerating to stop your momentum. With slew control, your spacecraft stops, and goes, wherever you want it to.

To turn Slew Control on

Y *Press to turn slew control on or off.*

▶ From the Flight menu, choose Slew Control.
–or–
Press the Y key.

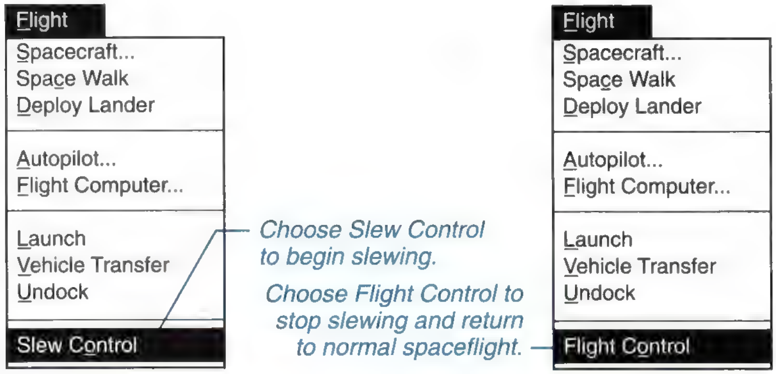
Space Simulator displays the word "Slew" in the lower-right corner of the view window.

When you choose Slew Control from the Flight menu, the command name changes to Flight Control.

To turn Slew Control off

▶ From the Flight menu, choose Flight Control.
–or–
Press the Y key.

Space Simulator no longer displays the word "Slew" in the lower-right corner of the view window.



Flying with Slew Control

When it comes to slewing, there's almost nothing new to learn. To keep things easy and allow for instant transition between standard flight control and slew control, you can use almost all the same keys.

However, there are a few exceptions:

- In slew control, the thrust and fine-thrust keys have the same direct effect on your spacecraft's velocity. In flight control, the thrust keys have a much larger effect on the magnitude of your spacecraft's acceleration than the fine-thrust keys do.
- In slew control, each time you press one of the thrust keys, you add significantly more velocity than you do in flight control. For example, when you press PAGE UP (or any other fine-thrust key) in flight control, your initial velocity is 0.002 meters per second, and each subsequent keystroke yields only a small incremental increase. When you press PAGE UP (or any other thrust key) in slew control, your initial velocity is 0.279 meters per second but each additional keystroke doubles the velocity, up to nearly the speed of light.
- In slew control, you apply reverse thrust by pressing SHIFT+KEYPAD MINUS SIGN, and you can apply it until your velocity is just below the speed of light. In flight control, you can only apply reverse thrust to achieve the slow accelerations of fine thrust.

For a complete and convenient guide to all the keys you'll need for slewing, choose Keyboard Guide from the Help menu, and then choose the Slew Control Keys button.

Slew control offers freedom from the laws of physics. Watch the instrument panel and you'll see. Because you are no longer bound by the laws of physics, your application of thrust is immediately translated into velocity—bypassing traditional acceleration and not even registering on the acceleration readout. When you are slewing, each time you press KEYPAD PLUS SIGN, you double your spacecraft's velocity. This progression begins with a velocity of 0.000 meters per second and builds to a maximum velocity of about 299,792 kilometers per second after 31 taps of KEYPAD PLUS SIGN.

By the way, that's fast! The speed of light is 299,792.5 kilometers per second. Out of respect for Albert Einstein, Space Simulator limits velocity to just below the speed of light.

Slewing to Ring Station 1

A great way to experience the power of slewing is to turn on the Slew Control command and see how close you can get to Ring Station 1. With slew control, you can approach objects with far greater precision than you can achieve with standard flight controls, which makes flying even more fun.

To prepare to slew to Ring Station 1

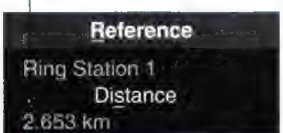
1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose FLIGHT, and then choose the OK button.

   Space Simulator sets the scene with the Earth and Ring Station 1 in front of you through your cockpit windshield.

Press ALT+R, or click here to change the reference object.



The distance readout displays the distance between your spacecraft and the reference object.

3. To change the reference object (which is now set for Earth), press ALT+R or click the reference display on the instrument panel.

   Space Simulator displays the Select Reference Object dialog box.

4. Under Object Type, choose Space Stations.

   Space Simulator displays a list of space stations.

5. From the list, choose Ring Station 1, and then choose the OK button.

   The reference display on the instrument panel shows the distance between your spacecraft and Ring Station 1. The velocity readout drops to zero because you are in an orbit parallel to that of the space station.

You're now ready to start slewing.

To slew to Ring Station 1

Y — *Press to turn slew control on or off.*

Press ALT+V to see the total velocity readout on the instrument panel.

For more information on steering your spacecraft, see "Steering Your Spacecraft with the Rotation Gauge and Attitude Display" on page 26.

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

1. From the Flight menu, choose Slew Control.

   Space Simulator displays the word "Slew" in the lower-right corner of the view window.

2. Press KEYPAD PLUS SIGN seven times.

   The velocity readout increases to 17.869 meters per second.

3. Steer a head-on course for Ring Station 1.

   You can use the keyboard, mouse, or joystick to control your spacecraft. If you are using the keyboard, you can press KEYPAD 5 to stop yaw, pitch, or roll.

4. Monitor the distance readout on the instrument panel (notice that every second you are getting nearer), and fly to within 750 meters of the space station.

5. Press KEYPAD MINUS SIGN seven times.

   This reduces your velocity to zero, and you remain at the same distance from the space station.

6. On the view tools, choose the Location button to cycle to Chase view.

   With Chase view, you'll get another perspective on how close your spacecraft is to Ring Station 1. Go ahead and try to get closer!

For comparison, try the same close approach without using slew control. You'll find it isn't nearly as easy to stop. Of course, there is great satisfaction in being able to maneuver your spacecraft with standard flight controls, but whenever you need an assist, slew control is waiting to be kicked into gear.

Going Backward with Slew Control

When you are slewing, you don't have to turn your spacecraft around and thrust in the reverse direction—you can just back up. This makes precision maneuvering much easier.

To slew backward

1. Press the HOME key to stop all forward velocity (or press KEYPAD MINUS SIGN to slow down until forward velocity is reduced to zero).

2. Press SHIFT+KEYPAD MINUS SIGN to throw your engines into reverse, and back up.

   Each time you press SHIFT+KEYPAD MINUS SIGN, you double the amount of reverse velocity.

You can test your slewing skills by using forward thrust to take your spacecraft up to Ring Station 1, and then using reverse thrust to back away from it.

Playing with Gravity (in the Name of Science)

For a complete and convenient guide to all slewing keys, choose Keyboard Guide from the Help menu, and then choose the Slew Control Keys button.

Because slewing protects you from gravity, the velocity readout on your instrument panel doesn't increase when you slew within range of the Earth's gravitational forces. You can learn about the effects of gravity at different altitudes; just turn off the Slew Control command (so you are traveling with standard flight control) and watch as your spacecraft's velocity increases as the Earth draws you near.

For a walk-through of the simple mathematical formula used to compute gravitational pull, see "Advanced Space Piloting" on page 161. But for now, just remember that the closer you get to an object such as a planet, the stronger the gravitational pull is on your spacecraft (except, of course, when you are slewing).

Here's a fun expedition that demonstrates this law of physics in action.

To see gravity increase as you near the Earth

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose FLIGHT, and then choose the OK button.

   You'll see the Earth and Ring Station 1 out your cockpit window. The reference display on the instrument panel shows that Earth is your reference object.

For more information on the reference display, see "Great Uses for the Reference Display" on page 66.

3. Press ALT+S to see the radius and altitude readouts.

   Watch the altitude readout to see how high you are above the surface of the Earth. (The distance readout displays how far you are from the core of the Earth.)

4. From the Flight menu, choose Slew Control.

   Space Simulator displays the word "Slew" in the lower-right corner of the view window.

5. Press KEYPAD PLUS SIGN several times to increase your velocity.

   Watch the velocity readout on the instrument panel—a speed of either 73 or 146 kilometers per second is enjoyable.

Press ALT+V to see the total velocity readout on the instrument panel.

6. When the altitude readout reaches about 20,000 kilometers, press HOME to stop thrust.

   Your spacecraft immediately stops. The velocity readout drops to zero.

Y *Press to turn slew control on or off.*

7. From the Flight menu, choose Flight Control to turn off the Slew Control command and return to standard flight control.

   Notice that the velocity readout shows a rapid increase. Gravity is accelerating your spacecraft toward Earth.

You can continue with this strategy as gravity draws you toward Earth. Every 5000 kilometers (or more frequently if you like), turn on the Slew Control command and press the HOME key to stop your progress and to return your velocity readout to zero. Then turn off the Slew Control command and write down what your velocity readout is after one minute. The nearer you get to Earth, the higher your one-minute velocity readings will be as gravity accelerates your spacecraft at a faster and faster pace.

Slewing Around Corners and Racing Through Time

One of the most enjoyable things you can do with slew control is to go racing around in space. If you need to turn sharp corners while chasing down an orbiting space station, or if you are trying to fly from one of Jupiter's moons to another, slew control can make maneuvering your spacecraft easier.

With standard flight controls, you use thrust to turn your spacecraft—but continual thrust means an ever-changing velocity, which after a while can become so great that you shoot past your destination. With slew control you can get to where you are going with steady thrust and steady velocity (though you can increase and decrease both simply by pressing KEYPAD PLUS SIGN and KEYPAD MINUS SIGN).

Slewing a Circle Around Ring Station 1

Let's hope that the occupants of Ring Station 1 aren't easily frightened, because it's time to do another close encounter of the slewing kind. This time we'll use slew control to fly completely around the outside of Ring Station 1.

To get ready for the trip, follow the procedure called "To prepare to slew to Ring Station 1" on page 48, and then fasten your seat belt!

To slew a circle around Ring Station 1

[Y] *Press to turn slew control on or off.*

1. From the Flight menu, choose Slew Control.

   Space Simulator displays the word "Slew" in the lower-right corner of the view window.

2. Press KEYPAD PLUS SIGN eight times.

   The velocity readout increases to more than 35 meters per second and you begin to draw nearer to the space station.

Press ALT+V to see the total velocity readout on the instrument panel.

3. Steer a course for Ring Station 1, keeping it slightly to the left of your spacecraft.

   You can use the keyboard, mouse, or joystick to control your spacecraft. If you are using the keyboard, you can press KEYPAD 5 to stop yaw, pitch, or roll.

4 When your spacecraft is within 1 kilometer of Ring Station 1, press KEYPAD MINUS SIGN twice to slow your velocity to about 8 meters per second.

5 Steer to the right of the space station (using the arrow keys, mouse, or joystick).

Keep your turn shallow, and remember (if you are using the keyboard) to press KEYPAD 5 to cancel your yawing motion and stop your turn. The idea is to keep the space station in view along the left of the screen, but don't turn in front of it. You want to keep it to your left as you circle around its back side.

You'll notice that Earth is passing out of sight on the right side of the screen. When Earth reappears on the left side of the screen you'll know you've just about completed a full circle around Ring Station 1.

Chasing the Earth Through Time

Slew control is also great for racing through time. When altering the passage of time (whether you are setting the time scale for 4.3 seconds per second or 4.3 years per second), slewing helps to stabilize your velocity. If you don't turn on the Slew Control command and you increase the time scale, you'll find your spacecraft speeding along at a pretty wild pace.

To chase the Earth using the time scale

Y *Press to turn slew control on or off.*

1 From the Flight menu, choose Slew Control.

Space Simulator displays the word "Slew" in the lower-right corner of the view window.

2 From the Location menu, choose Stars.

Space Simulator displays the Stars dialog box.

3 From the list, choose Our Sun (take a look at the Description box for more information on the Sun), and then choose the OK button.

4 From the Options menu, choose Preferences.

Space Simulator displays the Preferences dialog box.

5 Under Category, choose Labels.

6 Choose the Planets check box (so you can see labels on the planets), and then choose the OK button.

For more information on steering your spacecraft, see "Steering Your Spacecraft with the Rotation Gauge and Attitude Display" on page 26.

7 Yaw or pitch your spacecraft until you see the Earth.

A good tip is that the planets are aligned—once you find one, you can easily find the rest.

8 Press ALT+R or click the reference display on the instrument panel to change the reference object (which is now set for Our Sun).

Space Simulator displays the Select Reference Object dialog box.

9 Under Object Type, choose Planets.

Space Simulator displays a list of the planets.

10 From the list, choose Earth, and then choose the OK button.

The reference display now shows the distance between your spacecraft and the core of the Earth.

Press ALT+V to see the total velocity readout on the instrument panel.

11 Press KEYPAD PLUS SIGN and increase thrust until the velocity readout on the instrument panel displays about 1170 kilometers per second.

You can set your velocity slower or faster, as you like.

12 Press F1 or click the up arrow on the time scale in the lower-left corner of the instrument panel to increase the time scale to 8.5 minutes per second.

For more information on adjusting the time scale, see "Playing with Time" on page 34.

This gives you an effective speed of about 597,000 kilometers per second. (You can set your time scale slower or faster, as you like.)

13 Maneuver your spacecraft (with the keyboard, mouse, or joystick) so that you are heading straight toward the Earth.

14 When you are within 16 million kilometers of the Earth, press F2 or click the down arrow on the time scale to decrease the time scale to 2.1 minutes per second.

You can set the time scale lower or higher; just find a setting that you like.

15 Continue to lower the time scale as you draw nearer to Earth.

When you are within 3 million kilometers of the Earth, decrease the time scale to a rate of about 16 seconds per second (or slower), otherwise you may go blasting past the Earth.

16 Once you're within about 200,000 kilometers of the Earth, decrease the time scale to 1 second per second (a quick way to do this is by pressing SHIFT+F2).

With the time scale back to normal, you can either slow your spacecraft further by slowing the time scale to less than 1 second per second, or turn your attention to the velocity readout and reduce thrust.

17 Press KEYPAD MINUS SIGN to reduce thrust.

Sit back as you approach the Earth for a closer look. And then . . . crank up the time scale and velocity again and go out in search of Venus, Mars, or whatever other planet you want to visit.

Strategies for Slew Control

Slew control provides a simpler and a seemingly more logical manner than using standard flight controls for moving around the galaxy, but this doesn't mean you'll want to slew all the time.

In Space Simulator, you can use standard flight controls to get the most realistic feel for traveling through the vacuum of space, and for enjoying the universal tug of gravity. Or you can turn on the Slew Control command and experience less demanding and more relaxed space travel. The following are just some of the strategies you can use to incorporate slewing into your celestial journeys through Space Simulator.

Learning how to fly The Slew Control command can help you learn basic spaceflight skills. Because you don't have to worry about gravity or momentum, you can get to know your flight controls—thrust, fine thrust, and rotation—without having to deal with the more demanding realities of spaceflight. After you learn how to slew, you can turn off the Slew Control command and apply your experience in the presence of gravity and momentum.

Positioning your spacecraft During normal spaceflight, you can shift quickly into slew control to execute critical and precise maneuvers. For example, if you want to get very near to a space station, you can use slew control to position your spacecraft without fear of crashing.

Creating space photographs and space videos You can use slew control to set up breathtaking scenarios for space photographs or videos. Turn on the Slew Control command and maneuver your spacecraft exactly where you want it. Then take the perfect photograph or start recording your video.

Surviving close encounters Slew control is especially helpful when conducting near-surface explorations of planets and other bodies. Because gravitational pull increases the nearer you are to a massive object, great velocities are required to retain a low orbit. With slew control, you can fly your spacecraft to as low an orbit as you like without worrying about retaining orbital velocity.

Crossing great distances If you enjoy crossing vast expanses of space without having to use the autopilot and flight computer, you can turn on the Slew Control command and remove the aggravation of lengthy journeys and mathematical calculations. No more applying thrust across several light-years of space or figuring out the proper amount of reverse thrust to arrive at your target and enter into a stable orbit.

Chasing planets and other orbitals It's fun to chase planets, moons, comets, and other orbiting objects with your spacecraft. Expert star-pilots might be able to do this without slew control, but while you're learning, slew control is like having a space-bound sports car with great traction—you don't have to worry about momentum spinouts while you're trying to turn in space.

Slewing Just for the View of It

There are many reasons to slew, but perhaps the most compelling is to slew just for the view of it. Slewing throughout the galaxy and beyond, you can easily adjust your position to create wonderful views. In the next two expeditions you'll use slew control to travel first to the core of our

galaxy, and then to a point above it so you can look down upon its spiraling beauty.

To slew to the center of our galaxy

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

Press the PAUSE key if you want to stop the action for a moment. Press PAUSE again to resume action.

2. From the File Name list, choose FLIGHT, and then choose the OK button.

   Space Simulator sets the scene with the Earth and Ring Station 1 in front of you through your cockpit windshield.

3. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

4. Under Category, choose Scenery, and then choose the Milky Way check box.

   Note that when you choose the Milky Way check box, you make a tradeoff: image quality for frame rate. Later, you can choose the check box again to turn off the Milky Way and improve your computer's performance. For more information on performance and image quality, see "Performance" on page 183.

5. Choose the OK button.

   Now you'll be able to see the blue haze of the Milky Way as you begin your travels to the core of the galaxy.

Y *Press to turn slew control on or off.*

6. From the Flight menu, choose Slew Control.

7. Press ALT+R or click the reference display on the instrument panel to change the reference object.

   Space Simulator displays the Select Reference Object dialog box.

8. Under Object Type, choose Deep Sky.

   Space Simulator displays a list of deep sky objects.

9. From the list, choose Galactic Core (take a look at the Description box for more information on the core of the Milky Way), and then choose the OK button.

   The Galactic Core is now your reference object. The distance readout displays the distance between your spacecraft and the core of the galaxy.

For more information on steering your spacecraft, see "Steering Your Spacecraft with the Rotation Gauge and Attitude Display" on page 26.

10. Steer your spacecraft so it is heading just to the right of the Earth.

    You can use the arrow keys, the mouse, or joystick to adjust your heading. The object is to avoid crashing into the Earth.

11. Press the END key to apply full thrust.

    The velocity readout on the instrument panel registers just below the speed of light!

12 Adjust the time scale to a setting you like.

A time scale of about 68 years per second is nice. If you are exceptionally patient, you can leave the time scale at 1 second per second. At this setting, the 50,000 light-years journey to the center of our galaxy, even at near light-speed velocity, will take about 50,000 years.

The galactic core is the brightest and most star-filled area of the galaxy.

13 When the distance readout shows that you're within 30,000 light-years (LY) of the galactic core, steer right, toward the center of the galaxy.

Or—if you want a more total view of the galaxy that now surrounds you—turn completely around a few times.

Now, continue your slewing voyage and travel to within 1000 light-years of the galactic core. At this point, you'll pitch the nose of your spacecraft upward to head out of and above the plane of the galaxy.

To see our galaxy from above

1 Continue down toward the galactic core (as described in the preceding procedure).

For more information on how to pitch your spacecraft, see "Pitching" on page 28.

2 When the distance readout on the instrument panel shows that you are about 1000 light-years (LY) from the galactic core, pitch the nose of your spacecraft up until the pitch readout on the instrument panel displays a reading of about 40 degrees.

Soon you are flying above the galaxy where the view is spectacular!

3 Press ALT+LEFT ARROW or ALT+RIGHT ARROW, or drag the panning box with the mouse until it is at either end of the horizontal panning bar.

When you move the panning box completely to either end of the horizontal panning bar, you are looking directly out the back of your spacecraft. Watch as the galaxy begins to drift away behind you.

4 Press F1 or click the up arrow on the time scale in the lower-left corner of the instrument panel to increase the time scale to 272 years per second.

You can go faster or slower if you like. Either way, a glorious view of our spiraling galaxy as seen from above begins to take shape. Enjoy the sight!

5 Press KEYPAD ASTERISK (*) three or four times.

The galaxy appears to spin magically before you—but it is actually the shifting view as your spacecraft rolls on its longitudinal axis.

W *Press to turn Full Screen View on or off.*

6 From the Window menu, choose Full Screen View.

With all the galaxy to look at, you'll want as large a window as possible.

It's a magnificent view! Our island of a galaxy, harboring so many stars and so many worlds, spirals below your spacecraft.

Besides creating more enjoyment, variety, and precision in space travel, Space Simulator offers slew control for one important reason—to make life easier for you as you journey into the starry realms.

In the next chapter, we'll take a closer look at how to get the most from Space Simulator.

Chapter 6
Getting the Most from Space Simulator

"... I would look at the Earth as it would be gliding underneath me and think, How everlasting all this is. After I am gone, and my children, and my grandchildren, our Earth will still be gliding through the eternity of space in its measured, unhurried way."—Vladimir Solovyov, Russian astronaut (from The Home Planet)

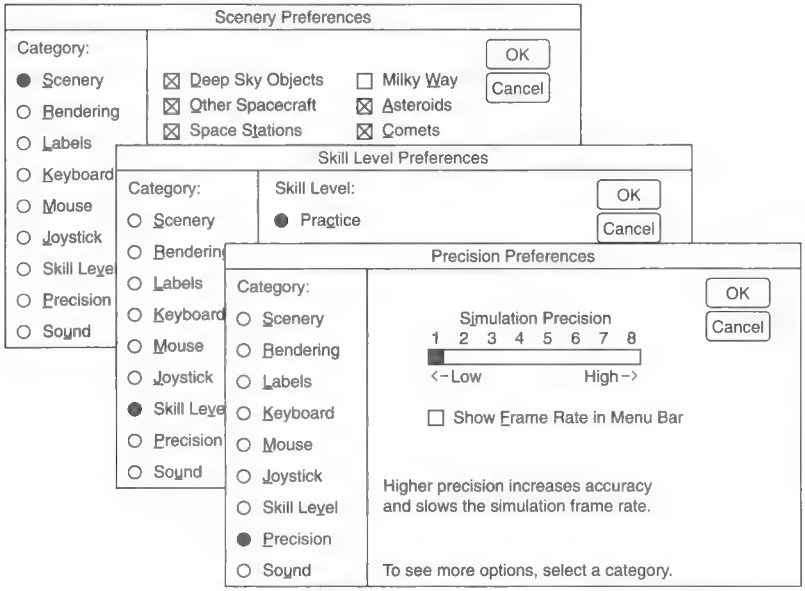
In this chapter, you'll learn how to

- Use the Preferences command to customize Space Simulator.
- Get the most from the reference display.
- Launch great adventures using the Set Location command.
- Use the head-up display.
- Get the most from view controls.

Now that you've learned how to operate your spacecraft, it's time to take a closer look at how to create your own personalized version of Space Simulator and at how to get the most from the instrument panel and controls.

Changing Preferences

The Preferences command on the Options menu functions as Space Simulator's electronics center. You get nine dialog boxes in one. Each time you choose a category, the contents of the dialog box change to offer new options.



Turning on the Frame-Rate Display

Before you start adjusting preferences, try turning on the frame-rate display—it's a built-in speedometer that monitors the number of frames per second. The higher the frame rate, the more smoothly the images appear as you travel through space. When you turn on the frame-rate display, you can see exactly what impact changing preferences has on your simulator display.

To turn on the frame-rate display

1. From the Options Menu, choose Preferences.

   Space Simulator displays the Preferences dialog box. The title of the dialog box changes depending on the category that you choose.

2. Under Category, choose Precision.

   Space Simulator displays the Precision Preferences on the right side of the dialog box.

For information on changing the rate of simulation precision, see "Setting Precision Preferences" on page 65.

3. Choose the Show Frame Rate In Menu Bar check box to turn the frame-rate display on or off.

   An X in the check box means the option is turned on. A blank check box means it is turned off.

4. Choose the OK button.

   Space Simulator now shows the frames per second in the upper-right corner of the menu bar.

Now you'll be able to see the results of all your other preferences decisions as you try them out.

Choosing Scenery Preferences

Scenery options affect what you see on the screen, as well as your display rate. For example, when you turn on the Milky Way, you'll see a noticeable drop in the frames-per-second rate, but you'll be able to admire the beautiful and realistic backdrop of this galaxy as you explore space.

Another scenery preference that changes the frames-per-second rate is the Star Limiting Magnitude option. Space Simulator's initial setting for star limiting magnitude is 6, a setting that displays stars down to the sixth magnitude. You can change the star limiting magnitude, but remember—when the magnitude number is higher (toward the faint end of the scale), you'll see more stars but the frames per second will be slower.

To choose scenery preferences

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Scenery.

   Space Simulator displays the Scenery Preferences on the right side of the dialog box.

Choose Constellation Boundaries to see outlines of the constellations.

3. Choose any of the check boxes to turn them on or off.

   An X in the check box means the option is turned on. A blank check box means it is turned off.

4. Press keys 1 through 7 (on the keyboard, not the keypad) to change the star limiting magnitude. You can also click the Star Limiting Magnitude scale to choose the star limiting magnitude you want.

   When you choose low numbers or the bright end of the scale, Space Simulator displays fewer stars (only the brightest). When you choose high numbers or the faint end of the scale, Space Simulator displays more stars.

5. Choose the OK button.

   Your new scenery preferences are now in effect.

Play with the choices and watch your screen for results. When you've gone from one extreme to the other, you'll find the combination of scenery preferences that you like best.

Adjusting Rendering Preferences

The rendering preferences provide another area in which you can have a great impact on the beauty or speed of Space Simulator. It's a tradeoff — you can choose between roughly drawn objects that have a fast frame rate or beautifully shaded objects with smooth texturing that take longer to display.

To choose rendering preferences

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Rendering.

   Space Simulator displays the Rendering Preferences on the right side of the dialog box.

3. Under Shading, choose either Solid or Dithered, and then choose either Faceted or Smooth.

   - Choose Solid for basic shading and a somewhat faster frame rate.
   - Choose Dithered for more blended shading (and more realistic images), but a slower frame rate.
   - Choose Faceted for basic objects and a faster frame rate. With Faceted shading, you can see the straight lines that form the basic structure of moons, planets, and stars.
   - Choose Smooth for beautiful shading that gives a smooth, round, realistic appearance to planets, moons, and stars.

4. Under Detail, choose either Sparse or Complex.

   - Choose Sparse for less detail on surfaces of moons, planets, and stars, but a faster frame rate.
   - Choose Complex for more surface detail, but a slower frame rate.

5. Under Ambient Light, choose either Normal or Bright.

   - Choose Normal for normal lighting conditions (in your computer room).
   - Choose Bright for bright ambient lighting.

6. Choose the OK button.

   Your new rendering preferences are now in effect.

It's easy to see results when you make changes in the Rendering Preferences dialog box. For example, choose one of the planets from the Location menu, and then play with the Rendering Preferences while you watch the frame-rate display. When you choose minimal display options (solid and faceted shading with sparse detail), you get a faster frame rate but a less attractive view of the planet. When you choose maximum display options (dithered and smooth shading with complex detail), you get a somewhat slower frame rate but the most realistic display.

Choosing Label Preferences

Labels keep you from getting lost in space!

In the Label Preferences dialog box you can label the constellations, deep sky objects, stars, planets, moons, asteroids, comets, spacecraft, and space stations.

Note that when there are too many labels on the screen they can overlap and block each other out.

The Label Preferences dialog box offers flexibility, too. For example, when you are near the planet Saturn, you can turn on the labels for moons. In this way, you can identify the moons as they orbit Saturn, but not be bothered with the clutter of additional labels for constellations, deep sky objects, and stars.

To choose label preferences

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Labels.

   Space Simulator displays the Label Preferences on the right side of the dialog box.

When you choose the Map Objects check box, Space Simulator displays labels in Map View, too. Remember, you can press the M key to display Map View or make it active.

3. Choose any of the check boxes to turn specific labels on or off.

   An X in the check box means the option is turned on. A blank check box means it is turned off.

4. Choose the OK button.

   Your new label preferences are now in effect.

While you are in your spacecraft flying around in space, you can turn labels on or off any time you want.

To quickly turn labels on or off

L *Press to turn labels on or off.*

- Press the L key.

  When you press the L key, Space Simulator turns on all labels. When you press the L key again, Space Simulator turns off all labels (except those that you turned on in the Label Preferences dialog box).

Adjusting Keyboard Preferences

In the Keyboard Preferences dialog box, you can change the way your spacecraft responds to keyboard controls for yaw, pitch, and roll. You can adjust keyboard sensitivity and decide which keys you want to use for pitch control.

To adjust keyboard sensitivity

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Keyboard.

   Space Simulator displays the Keyboard Preferences on the right side of the dialog box.

3. Press keys 1 through 8 (on the keyboard, not the keypad) to change keyboard sensitivity. You can also click the Keyboard Sensitivity scale to choose the keyboard sensitivity you want.

Choose lower numbers for less sensitivity and higher numbers for more sensitivity.

4 Choose the pitch control keys you want.

In Space Simulator, the keyboard pitch controls are initially set to simulate those of a real spacecraft—you push the controls forward to pitch down (KEYPAD 8 or UP ARROW) and pull the controls back to pitch up (KEYPAD 2 or DOWN ARROW). You can change the pitch control functionality by choosing the option you want.

5 Choose the OK button.

Your new keyboard preferences are now in effect.

Adjusting Mouse Preferences

In the Mouse Preferences dialog box, you can change the way your spacecraft responds to mouse controls. You can adjust mouse sensitivity, or how quickly the mouse responds when you move it, and you can adjust null-zone sensitivity, or the amount of "slack" you want as you move your mouse. Experiment with the mouse sensitivity and null-zone settings to find the combination that you like best.

To adjust mouse sensitivity

1 From the Options menu, choose Preferences.

Space Simulator displays the Preferences dialog box.

2 Under Category, choose Mouse.

Space Simulator displays the Mouse Preferences on the right side of the dialog box.

3 Press ALT+E, and then press keys 1 through 8 (on the keyboard, not the keypad) to change mouse sensitivity. You can also click the Mouse Sensitivity scale to choose the mouse sensitivity you want.

Choose lower numbers for less sensitivity and higher numbers for more sensitivity.

4 Press ALT+Z, and then press keys 1 through 8 (on the keyboard, not the keypad) to change null-zone sensitivity. You can also click the Mouse Null Zone scale to choose the null-zone sensitivity you want.

Choose lower numbers for less sensitivity and higher numbers for more sensitivity.

5 Choose the OK button.

Your new mouse preferences are now in effect.

Adjusting Joystick Preferences

In the Joystick Preferences dialog box, you can change the way your spacecraft responds to joystick controls. You can adjust joystick sensitivity, or how quickly the joystick responds when you move it, and

you can adjust null-zone sensitivity, or the amount of "slack" you want as you move your joystick. Experiment with the joystick sensitivity and null-zone settings to find the combination that you like best.

You can also turn your joystick on or off and calibrate it in the Joystick Preferences dialog box.

To adjust joystick sensitivity

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Joystick.

   Space Simulator displays the Joystick Preferences on the right side of the dialog box.

3. Under Joystick, make sure that your joystick is turned on.

   You can also turn off your joystick when you don't want to use it.

4. Press ALT+E, and then press keys 1 through 8 (on the keyboard, not the keypad) to change joystick sensitivity. You can also click the Joystick Sensitivity scale to choose the joystick sensitivity you want.

   Choose lower numbers for less sensitivity and higher numbers for more sensitivity.

5. Press ALT+Z, and then press keys 1 through 8 (on the keyboard, not the keypad) to change null-zone sensitivity. You can also click the Joystick Null Zone scale to choose the null-zone sensitivity you want.

   Choose lower numbers for less sensitivity and higher numbers for more sensitivity.

6. Choose the Calibrate button to fine-tune your joystick (you can also press the J key to calibrate the joystick at any time).

7. Choose the OK button.

   Your new joystick preferences are now in effect.

Choosing Skill Level Preferences

In Space Simulator, you can set your skill level at Practice, Intermediate, or Advanced so you can take it easy or challenge your knowledge of spaceflight.

To choose a skill level

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Skill Level.

   Space Simulator displays the Skill Level Preferences on the right side of the dialog box.

3 Under Skill Level, choose the option that is best for you.

- Choose Practice for the most forgiving flights—you won't have to worry about docking with precision or crashing when you land.
- Choose Intermediate for more challenging flights—you must pay more attention to fuel and spaceflight maneuvers.
- Choose Advanced for the most demanding challenges in spaceflight.

At the intermediate and advanced skill levels, you can experience a temperature crash if your spacecraft enters an atmosphere with too much velocity, or travels too near a star.

4 Choose the OK button.

Test your skill level as you fly.

Setting Precision Preferences

When orbiting an object with the time scale increased to several days per second or higher, choose a higher precision setting to keep your spacecraft from being flung out of orbit.

In the Precision Preferences dialog box, you can adjust the level of precision with which Space Simulator calculates orbital position data. The higher the setting on the simulation precision scale, the more precise the orbital position data, but the lower your frame rate. If you choose a lower setting on the simulation precision scale, Space Simulator's calculation of orbital position data is more approximate but frame rate is faster and smoother. You can also turn on the frame-rate display in the Precision Preferences dialog box.

To set the simulation precision

1 From the Options Menu, choose Preferences.

Space Simulator displays the Preferences dialog box.

2 Under Category, choose Precision.

Space Simulator displays the Precision Preferences on the right side of the dialog box.

3 Press keys 1 through 8 (on the keyboard, not the keypad) to change simulation precision. You can also click the Simulation Precision scale to choose the simulation precision you want.

Choose lower numbers for a faster frame rate and higher numbers for increased accuracy but a slower frame rate.

For information on turning on the frame-rate display, see "Turning on the Frame-Rate Display" on page 59.

4 Choose the Show Frame Rate In Menu Bar check box to turn the frame-rate display on or off.

An X in the check box means the option is turned on. A blank check box means it is turned off.

5 Choose the OK button.

Your new precision preferences are now in effect.

Choosing Sound Preferences

In the Sound Preferences dialog box, you can change your sound settings. You can hear sound effects when you launch your spacecraft, apply thrust, dock, land, or crash. You can play music to enhance the wonder of spaceflight. Or, if you want, you can turn all sound off.

To choose sound preferences

1 From the Options menu, choose Preferences.

Space Simulator displays the Preferences dialog box.

2 Under Category, choose Sound.

Space Simulator displays the Sound Preferences on the right side of the dialog box.

Q *Press to quickly turn sound on or off.*

3 Under Sound, choose the option that is best for you.

- Choose Off to turn sound off completely.
- Choose Sound Effects to turn on sounds, such as launching your spacecraft, applying thrust, docking, landing, and crashing.
- Choose Music to turn on musical accompaniment for your journey through the spheres, choose the Select Music button and select the music you want (noting the information in the Description box), and then choose the OK button.

4 Choose the OK button to return to spaceflight.

If you turn on sound effects or music, you'll need to exit and restart Space Simulator to hear sounds.

Great Uses for the Reference Display

In previous chapters you've used the reference display to orient yourself in space, but now let's take a closer look at it. The reference display is your touchstone, your link to reality. Since there is no up or down in space, no left or right, no apparent beginning or end, it helps to have a point of reference during your travels—in Space Simulator, that's your reference object.

For a quick review of the reference display, see "Reading the Reference Display" on page 39.

Whether flying or slewing in space, a good first step in embarking on a journey is to set your destination (or the first leg of your trip) as the reference object. This way, you'll keep posted on how many kilometers you have left in your voyage, and, if you make the reference object your tracking object, you can keep your sights on your destination as you fly.

Using the Reference Display for Precision Maneuvers

The reference display is a tremendous tool for tight maneuvers or precision docking. To see how it can really come in handy, try the following adventure.

To fly dangerously close to Ring Station 1

If you want to embark on another adventure to test your skills using the reference display, see the procedure "To play with the Moon's gravity well" on page 42.

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose FLIGHT, and then choose the OK button.

   Space Simulator sets you up with Ring Station 1 right in front of you through your cockpit window and the Earth beyond.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

3. On the view tools, choose the Location button and cycle to Chase view so you can view your spacecraft as you fly.

4. Press ALT+R or click the reference display on the instrument panel to change the reference object from Earth to Ring Station 1.

   Space Simulator displays the Select Reference Object dialog box.

5. Under Object Type, choose Space Stations.

   Space Simulator displays a list of space stations.

6. From the list, choose Ring Station 1, and then choose the OK button.

   The reference display on the instrument panel shows the distance between your spacecraft and Ring Station 1.

7. Press ALT+S or click below the reference object on the instrument panel to change the reference display from distance to radius and altitude.

   The altitude readout shows that you are a little more than 2 kilometers away from Ring Station 1.

For more information on accelerating and steering your spacecraft, see "First Flight" on page 18.

8. Apply thrust and steer your spacecraft in the direction of Ring Station 1, and then use the altitude readout to fly as closely as you can to the space station.

Whether you are approaching a space station, planet, or moon, or attempting to dock, the reference display provides the precision information you need to make safe close encounters.

Using the Reference Display to Get Your Bearings

Wherever you are in space, you can always find the distance to your next object of interest simply by choosing it as your reference object. For example:

If you want to change your reference object, press ALT+R or click the reference display on the instrument panel, and then choose the reference object that you want.

- If you are in Earth orbit, and want to know how far away the Moon is, just change your reference object to the Earth's Moon. The distance readout on the reference display indicates how many kilometers away you are.
- If you've landed your spacecraft on the surface of Mars, and want to know which of its two moons is nearest to you, just change your reference object to Phobos, and then to Deimos.

Press SHIFT+ the PERIOD (.) key or SHIFT+ the COMMA (,) key to cycle through the available reference objects.

- If you want to find which comet is nearest to your current location, just continue changing your reference object to each of the available comets and watch the distance readout until you find the nearest one.

In addition to seeing how far you have to go, you can use the reference display to see how far you've already gone. For example, if you're cruising around the stars, and want to know how far away you are from our solar system, just set your reference object for our Sun. The distance readout shows how far you've wandered from home.

Tracking the Reference Object

D *Press to switch between Panning and Tracking modes.*

When your reference object is the same as your tracking object, you can quickly change to your tracking object by switching your view direction from panning to tracking. Remember that tracking fixes your focus on a specific object, keeping it centered on your screen as you fly. Some fun ideas for tracking your reference object follow:

- If you are flying from Earth to Mars, and are somewhere in the vicinity of the Moon, just change your reference object to the Moon and watch the Moon come and go as you pass by it on your way to the red planet.

T *Press to change your tracking object.*

- If you are flying past Jupiter, change your reference object to one of its moons—for example, Callisto—and track the moon's movements when you aren't watching the great Jovian giant.

Launching Great Adventures with the Set Location Command

The Set Location command on the Location menu is your gateway to many exciting adventures. It is the most precise way to choose an exact position and distance from your reference object.

Let's take a look at how you can use the Set Location command to place your spacecraft in a very hot orbit around the Sun.

To set your location above our Sun

1. From the Location menu, choose Set Location.

   Space Simulator displays the Set Location dialog box.

2. Choose the Base Object button.

   Space Simulator displays the Select Base Object dialog box.

3. Under Object Type, choose Stars.

   Space Simulator displays a list of available stars.

4. From the list, choose Our Sun (noting the information in the Description box), and then choose the OK button.

   Space Simulator returns you to the Set Location dialog box, and lists Our Sun as the current base object.

5 In this example, you don't need to change latitude and longitude information. However, if you need to do so in the future, simply type in the exact coordinates.

6 Choose Altitude Above Surface, and then change the altitude reading to 1.

Be sure that you choose Altitude Above Surface and not Distance From Center, otherwise you'll end up inside the Sun.

7 Choose Million Kilometers as the measurement unit.

You can choose among several measurement units (Meters, Kilometers, Million Kilometers, Astronomical Units, Light-Years, and Radii).

8 Under Update, choose the Reference Object check box.

An X in this check box means the option is turned on and the Sun is now your reference object. Make sure that the Tracking Object check box is turned off so that your spacecraft remains the tracking object.

9 Choose the OK button.

Space Simulator returns you to spaceflight. The reference display on the instrument panel corroborates that Our Sun is your reference object.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

10 Choose Chase view as your viewing location, and then press SHIFT+KEYPAD 6 to position the chase craft off the right side of your spacecraft.

You are now in a chase craft watching your spacecraft track the Sun, at an altitude of 1 million kilometers above the surface. As you fly your spacecraft, the Sun stays in view.

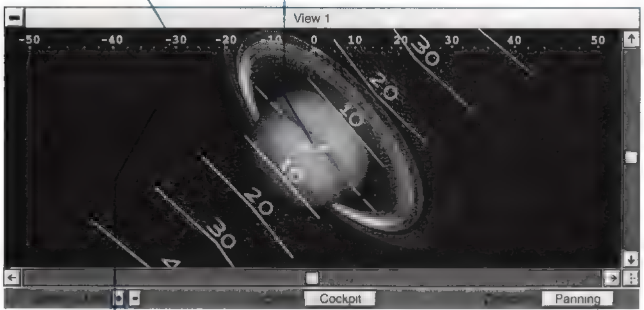
You can use the Set Location command to place yourself anywhere you want—dangerously near the Sun's blazing landscape, hovering just above the craters of the Moon, or alongside a speeding comet. You can also enter exact latitude and longitude and find yourself at a chosen location on the surface of the Earth, or on any other planet, moon, or star.

Using the Head-Up Display

The head-up display is superimposed on the cockpit windshield so you can see spaceflight-related information without taking your eyes off the flight path. Especially nice for dockings and other precision maneuvers, the head-up display is a welcome assistant, giving you feedback on your yaw, pitch, and roll attitudes. You can also refer to the attitude display on the instrument panel for exact numerical readouts for yaw, pitch, and roll.

The green numbers at the top of the head-up display provide a visual guide for calculating your spacecraft's turns to the left or right (yaw) in 10-degree increments.

The yellow line in the center of the head-up display is your spacecraft's axis indicator. The dotted green line is the equatorial plane of the current reference object.



The blue and red attitude grid of the head-up display provides a visual guide for calculating your spacecraft's nose-up and nose-down attitude (pitch) in 10-degree increments.

You can also calculate your spacecraft's roll attitude by watching the red and blue grid as it rotates around the yellow axis indicator in the center of the head-up display.

Keeping the Head-Up Display in View

For continuous operation of the head-up display, you'll need the following settings on the view tools:

- Set the Location button on Cockpit view—if you cycle to Chase or Assigned view, the head-up display automatically turns off.
- Set the Direction button on Panning mode—if you switch to Tracking mode, the head-up display automatically turns off.
- Center the horizontal and vertical panning bars—if you pan away from the center position, the head-up display automatically turns off.

The head-up display only functions in ideal conditions to supply you with accurate readings of your spacecraft's orientation. When the head-up display automatically turns off, it does so to protect your spacecraft and its passengers.

To use the head-up display

1. From the Location menu, choose Planets.

   Space Simulator displays the Planets dialog box.

2. From the list, choose Saturn, and then choose the OK button.

   The rings of Saturn make the planet a fun object to use with the head-up display.

H *Press to quickly turn the head-up display on or off.*

3 From the Window menu, choose Show Head-Up Display.

Space Simulator superimposes the head-up display on your cockpit window. Note that the blue and red attitude grid is set at an angle that matches the equatorial rings of Saturn.

Don't forget that you can quickly stop rotation by pressing KEYPAD 5.

4 Roll your spacecraft to the right (press the ASTERISK (*) key on the keypad) until the blue and red grid of the head-up display is straight up and down, and hold it there.

Note that the grid is still parallel with Saturn's equator (and its equatorial rings).

Don't worry about stopping your pitch readout at exactly 90 degrees. Getting within a degree or two is close enough. If you want closer tolerances, choose Preferences from the Options menu, choose Keyboard, and then choose a lower setting on the Keyboard Sensitivity scale for less rotational movement per keystroke.

5 Rotate the nose of your spacecraft upward until you reach 90 degrees of pitch, and hold it there.

As you pitch upward, the blue lines of the attitude grid show your progress in 10-degree increments. When you reach 90 degrees of pitch, the blue plus sign (+) is centered on the yellow line in the center of the display, and your spacecraft is pointing toward Saturn's north pole.

6 Rotate the nose of your spacecraft downward until you reach 90 degrees of pitch, and hold it there.

As you pitch downward, the red lines of the attitude grid show your progress in 10-degree increments. When you reach 90 degrees of pitch, the red plus sign (+) is centered on the yellow line in the center of the display, and your spacecraft is pointing toward Saturn's south pole.

For more information on maneuvering your spacecraft, see "Steering Your Spacecraft with the Rotation Gauge and Attitude Display" on page 26.

7 Rotate the nose of your spacecraft back up to 0 (zero) degrees of pitch, then turn your spacecraft to the right until you reach 90 degrees of yaw, and hold it there.

The green numbers across the top of the head-up display show the degree of your turn from the polar center of the planet. At 90 degrees, your spacecraft is parallel to the planet (a good position for establishing an orbit). At 180 degrees, your spacecraft is pointing directly away from the planet.

8 Turn your spacecraft to the left until you reach 90 degrees of yaw, and hold it there.

The head-up display measures turns to the left in negative degrees. At -90 degrees of rotation, your spacecraft is parallel to the planet, just as it is at 90 degrees.

Establishing an Orbit with the Head-Up Display

For your advanced piloting pleasure, you can use the head-up display to establish your own orbits around stars, planets, moons, and other celestial objects that you discover in your explorations. Test your skills with the head-up display by flying to the Earth's moon (because it's relatively close) and establishing an equatorial orbit around it.

To enter an equatorial orbit using the head-up display

For more information on establishing and modifying orbits, see "Advanced Space Piloting" on page 161.

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose FLIGHT, and then choose the OK button.

   Space Simulator sets you up with Ring Station 1 in front of you through your cockpit window and the Earth beyond.

For a complete and convenient guide to all the keys you need for flying your spacecraft or slewing, choose Keyboard Guide from the Help menu, and then choose the Flight Control Keys button or the Slew Control Keys button.

3. Press ALT+R or click the reference display on the instrument panel to change the reference object (which is now set for Earth).

   Space Simulator displays the Select Reference Object dialog box.

4. Under Object Type, choose Moons.

   Space Simulator displays a list of moons.

5. From the list, choose Earth's Moon, and then choose the OK button.

   The Earth's Moon is now your reference object. The distance readout displays the distance between your spacecraft and the Moon.

H *Press to quickly turn the head-up display on or off.*

6. From the Window menu, choose Show Head-Up Display.

   Space Simulator superimposes the head-up display on your cockpit window.

7. Center the head-up display, both horizontally and vertically, and fly straight for your reference object (in this case, the Earth's Moon).

   Center the green zero at the top of the screen by yawing left or right. Center the blue and red attitude grid so that the green dots between the blue 10-degree mark and the red 10-degree mark are directly on the yellow line in the center of the display.

If you arrive at the dark side of the Moon, click the time display on the instrument panel or press ALT+T, and then reset the date to 20 Apr 2000.

8. Apply thrust, and slew or fly to the Moon, monitoring the distance readout on the reference display as you travel toward your destination.

9. Keep the head-up display centered, both horizontally and vertically.

   Make small corrections by yawing and pitching your spacecraft.

10. When you get close enough to the Moon, press ALT+S or click the reference display so you can see altitude and radius readouts.

11. At 3 radii from the Moon, stop all thrust and velocity.

    Remember to press HOME to stop thrust and press F4 to stop velocity.

To position your spacecraft for a polar orbit, use the head-up display to establish a pitch of 90 degrees.

12. Yaw 90 degrees to the right or left to position your spacecraft for an equatorial orbit.

    Watch the green numbers on the head-up display and hold when you reach 90 degrees (or -90 degrees if you are yawing to the left).

13. From the Help menu, choose Basic Skills, choose the Spaceflight Skills button, and then refer to the orbital velocity table for the proper velocity and altitude combinations to enter an equatorial orbit.

The head-up display is an excellent seat-of-the-pants piloting guide—just make your destination the reference object, and then zero in on it!

Getting the Most from View Controls

The view controls are a powerful and flexible means of seeing space from different perspectives—from close range or far away—as you make long voyages or attempt precision maneuvers. Here are some additional uses for the view controls.

Cycling Through Views Without Losing Settings

Space Simulator automatically stores your settings for each view. As you cycle through Cockpit, Chase, and Assigned views, you can make adjustments to the zoom setting, panning bar locations, and viewing mode (Panning or Tracking) for a particular view without affecting the others.

For example, you can create the following custom settings:

A zoom readout of 2.00X is the normal field of vision. Space Simulator matches the human vision system so accurately that some fish-eye distortion occurs when viewing objects at a zoom setting lower than 2.00X. A higher number on the zoom readout indicates increased magnification; a lower number indicates decreased magnification.

- In Cockpit view—set the zoom at 2.00X, center the panning bars, and switch the viewing mode to Panning.
- In Chase view—set the zoom at 1.50X, pan horizontally or vertically to show off your spacecraft, and leave the viewing mode on Tracking.
- In Assigned view—set the zoom at 10.3X, center the panning bars, and leave the viewing mode on Tracking.

When you cycle through Cockpit, Chase, and Assigned views, your custom settings for each view remain exactly as specified.

Having Fun with Assigned View

You know how to use Assigned view for watching a spacecraft approach a space station and as the docking-port camera in docking procedures. You can also use Assigned view to watch celestial objects that are literally millions and billions of kilometers (or even light-years) away from you and your spacecraft. For example, you can set your Assigned view on one of Jupiter's moons, and then set the tracking object as Jupiter—you've now got a front-row seat for a spectacular view of the planet.

To track Jupiter from one of its moons

For more information on view controls, see "Looking Out Your Spacecraft Window" on page 6 and "Using the Docking-Port Camera" on page 90.

1. From the Window menu, choose View Controls.

   Space Simulator displays the View Controls dialog box.

2. Under View Location, choose Assigned to switch to Assigned view.

   This is essential. Unless you happen to be in the neighborhood, you won't see Jupiter up close from Cockpit or Chase view.

3. Choose the Assigned View button.

   Space Simulator displays the Select Assigned View Location dialog box.

4 Under Object Type, choose Moons.

Space Simulator displays a list of available moons.

5 From the list, choose Amalthea, the closest moon to Jupiter, and then choose the OK button.

Space Simulator returns you to the View Controls dialog box and displays the current Assigned view location (in this case, Amalthea) directly above the Assigned View button.

6 Under View Direction, choose Tracking to switch to Tracking mode.

This is essential. You won't see your tracking object, in this case Jupiter, unless the viewing mode is set for Tracking.

7 Choose the Tracking Object button.

Space Simulator displays the Select Tracking Object dialog box.

8 Under Object Type, choose Planets.

Space Simulator displays a list of available planets.

9 From the list, choose Jupiter, and then choose the OK button.

Space Simulator returns you to the View Controls dialog box and displays the current tracking object (in this case, Jupiter) directly above the Tracking Object button.

10 Choose the OK button.

You are now ready to view Jupiter from Amalthea, one of its nearest moons. This view provides a nice show, especially when you speed up time.

If you need to get some distance, press the MINUS key or click the Minus button on the view controls to zoom out until you can see the whole planet spinning.

11 Press F1 or click the up arrow on the time scale to speed up time to about one hour per second.

Watch as the beautiful spinning planet in front of you changes from dark to light and back again.

Now try it on your own. Use Assigned view with Tracking mode to watch any number of celestial objects that are far, far away. You can orbit the Earth, or even sit on the ground at Cape Canaveral, and still take in a view of Jupiter (or any other celestial object) whenever you switch to Assigned view. Let your imagination be your guide.

Viewing a Parade of Celestial Beauties

Another innovative use of a specific view when you are in Tracking mode is the combination of Chase view and Tracking mode. With this dynamic duo, you can change your tracking object quickly and easily. The result is a parade of celestial beauties, and a nice preview of all the objects you might want to visit.

To view a parade of celestial beauties

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

1. On the view tools, choose the Location button and cycle to Chase view.

   The Location button always displays the name of the current view location. Choose the button once and you cycle from Cockpit to Chase view. In Chase view, you see your spacecraft in front of you (from the perspective of a chase craft).

   When you choose Chase view, Space Simulator automatically switches your viewing mode from Panning to Tracking, and the initial tracking object is your spacecraft.

2. Press the PERIOD (.) key to cycle to the next tracking object or press the COMMA (,) key to cycle back to the previous tracking object.

   An easy way to remember these keys is to think of the GREATER THAN SIGN (>), which shares a key with the period, as an arrow pointing you to the next tracking object, and the LESS THAN SIGN (<), which shares a key with the comma, as an arrow pointing you back to the previous tracking object.

   Space Simulator displays the name of the tracking object in the title bar of the active window. For example, Space Simulator displays "View 1: Mars" in the title bar of View 1 to show that Mars is the tracking object.

3. Press the T key to switch back to a Chase view of your spacecraft.

   Space Simulator displays the Select Tracking Object dialog box.

4. Under Object Type, choose Spacecraft.

   Space Simulator displays a list of available spacecraft.

5. From the list, choose the name of your spacecraft, and then choose the OK button.

   Space Simulator returns you to a Chase view of your spacecraft.

T — *Press to change your tracking object.*

When you press the COMMA (,) key or the PERIOD (.) key, you can cycle through all the available tracking objects, starting with your spacecraft and continuing on down the list. To learn more about an object, press the T key and look for a detailed description in the Select Tracking Object dialog box. What an inviting way to preview future travel destinations!

Chapter 7
Touring the Spacecraft and the Space Stations

"The minutes of evening twilight are fabulous. The hull of the station is lit by the golden rays of the sun. The daylight part of the Earth with its pink clouds and evening haze above the surface is still visible while our spacecraft is already sailing into the blackness of night."—Vladimir Vasyutin, Russian astronaut (from The Home Planet)

In Space Simulator, the standard user fleet includes a mothership, a lander, and a manned maneuvering unit (MMU).

In this chapter, you'll learn how to

- Choose a spacecraft to suit your needs.
- Get ideas for embarking on multi-ship adventures.
- Visit the space stations.

Welcome to your personal tour of Space Simulator's spacecraft and space stations. As you admire the spacecraft's sleek exteriors, you'll also learn about propulsion systems, dimensions, performance, and accommodations for the spacecraft, as well the histories and functions of the space stations.

Choosing a Spacecraft

Space Simulator's awesome fleet of gleaming ships is at your command. You can transfer from one spacecraft to another whenever you want, without making any changes to your current situation.

To rendezvous with another spacecraft when you are flying a situation, choose Spacecraft from the Location menu. The availability of spacecraft changes, depending on the situation.

To choose a spacecraft

1. From the Flight menu, choose Spacecraft.

   Space Simulator displays the Spacecraft dialog box.

2. From the list of available spacecraft, choose the one you want.

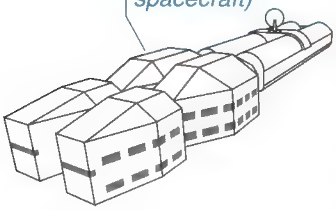
   Space Simulator displays a top view and side view of the spacecraft, as well as a description.

3. When you decide on the spacecraft you want to fly, choose the OK button.

   Space Simulator returns you to spaceflight in your new spacecraft.

Now let's take a tour of the shipyard to see what your choices are.

Galactic Explorer



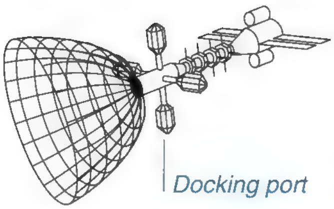
The Galactic Explorer is a large spacecraft built for visiting the vast unexplored realms of our galaxy. Its twin fuel tanks carry a hydrogen slush for its fusion reaction engines, which create enormous amounts of propulsion by fusing hydrogen atoms.

Although capable of acceleration up to 4 Gs, the Galactic Explorer is designed for traveling with a sustained 1 G of acceleration to provide an Earth-like gravity environment that is healthiest for the human body and least disorienting to the mind. During spaceflight, the local sense of down (the direction in which gravity is pulling you) is toward the engines at the back of the ship.

Although not as large as the Zander Freighter and the Bussard Ram-Jet, the Galactic Explorer offers the largest living areas, and features an open mall-like environment built around a beautiful atrium with thick stands of trees that are home to birds, bugs, squirrels, and raccoons.

Mass	10,000 metric tons
Length	200 meters
Propulsion system	Nuclear fusion
Maximum acceleration	4 Gs
Fuel duration at maximum acceleration	317 years

Bussard Ram-Jet



In the 1950s, American physicist Robert Bussard speculated that spacecraft could use huge magnetic funnels to gather interstellar hydrogen to fuel their fusion engines. Science-fiction writers soon picked up on the idea, creating great imaginary spacecraft for voyages into the future. Now you can fly your very own Bussard Ram-Jet through the vast realms of Space Simulator.

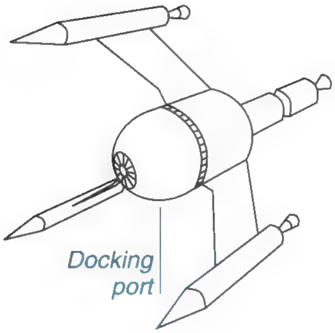
The Ram-Jet uses its internal fuel reserves to accelerate up to a fraction of the speed of light, and then the magnetic funnel begins to capture the interstellar hydrogen. A tightly focused beam of hydrogen is shot aft into the fusion reactors. The blue panels extending from the engine area are radiators that dissipate excess heat. The yellow tanks are used to store extra hydrogen for deceleration.

The Bussard Ram-Jet can only collect hydrogen fuel for its fusion reaction when its great magnetic funnel is pointed in the direction of travel. However, its auxiliary tanks are refilled whenever it is docked to a space station.

The living quarters are forward, extending outward from the core of the spacecraft to keep the occupants a safe distance from the high-energy particles streaming from the funnel to the fusion chamber.

Mass	10,000 metric tons
Length	400 meters
Propulsion system	Nuclear fusion
Maximum acceleration	2 Gs
Fuel duration at maximum acceleration	Unlimited (refuels)

Callisto



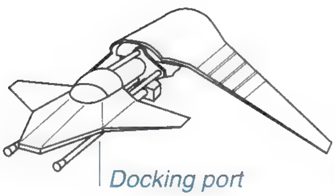
The Callisto is the most unusual of Space Simulator's spacecraft. It was found, not built.

Discovered in orbit around Jupiter's moon, Callisto, this spacecraft is propelled by the three artificial gravity drives that extend forward from the front of the spacecraft and create an artificial gravity well ahead of the Callisto that pulls it ever forward. Exactly how the artificial gravity drives work is still unknown, but it has been determined that they were created through fantastically advanced technology.

A full starship, the Callisto is popular among crews because its artificial gravity drives are also useful in creating a pleasant onboard gravity, which is important during long flights. The local sense of down is toward the gravity well created ahead of the spacecraft. When acceleration exceeds 1 G, the artificial gravity beam is focused farther ahead of the ship to retain a 1-G internal environment for the crew.

Mass	1000 metric tons
Length	132 meters
Propulsion system	Gravity synthesis
Maximum acceleration	4 Gs
Fuel duration at maximum acceleration	3000 years

F-79 Galactic Fighter



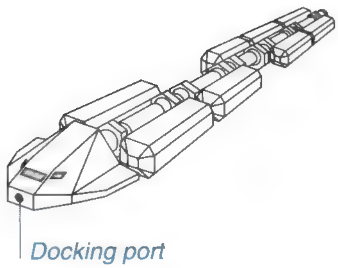
The F-79 Galactic Fighter is a direct descendant of the U.S. Air Force's F-16 Fighting Falcon. An extremely versatile spacecraft, it is capable of interstellar spaceflight, as well as atmospheric entry and landing.

Its antimatter engines provide it with an easy 8 Gs of acceleration. The crew, however, gets nervous when it is time to refuel—a single contaminant of matter during the loading of the antimatter could blow away the spacecraft and anything near it.

Although equipped with atomic and antimatter weaponry, the F-79 is mainly used as a rescue craft; it annihilates asteroids and comets that stray too near the Earth. One of the pleasant surprises about space is that once humans got there, they were so inspired by what they found that they lost interest in fighting!

Mass	100 metric tons
Length	40 meters
Propulsion system	Antimatter
Maximum acceleration	8 Gs
Fuel duration at maximum acceleration	30 years

Zander Freighter



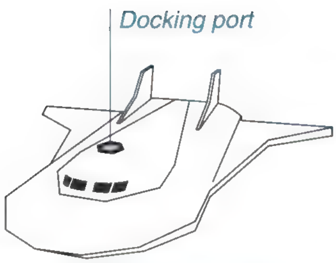
The Zander Freighter, at 1100 meters in length, is awesome to behold, especially from a manned maneuvering unit (MMU). Its orange cargo modules are dropped off at space stations, surface colonies, and asteroid mining sites, and replaced with other modules filled with items for transport to market.

Although the spacecraft can be operated completely by robots and automatic controls, a human presence is maintained. The long, quiet passages between ports of call make the Zander Freighter popular with poets, scholars, and others who seek solitude.

Although dwarfed by the cargo area, the living quarters are quite large and elegantly appointed—many fitted with oak-paneled walls, ornately plastered ceilings, spiral staircases, and creaking libraries (even though you can find the same information on the spacecraft computers). Crew members sometimes go for weeks at a time without seeing each other.

Mass	100,000 metric tons
Length	1100 meters
Propulsion system	Nuclear fusion
Maximum acceleration	2 Gs
Fuel duration at maximum acceleration	634 years

All Terrain Lander



G Press to extend or retract landing gear.

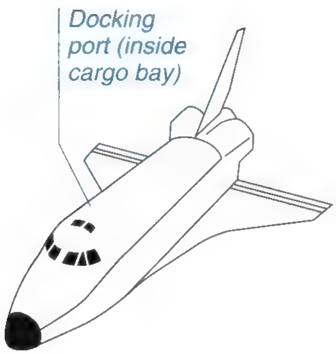
Watch the fuel gauge while flying. If the fuel level looks low, just dock to the mothership for automatic refueling.

The all terrain lander (ATL) is primarily used as transportation from an orbiting interstellar spacecraft to the surface of a planet or moon. The ATL is strong enough to withstand even the roughest atmospheric entries, and has vertical takeoff and landing abilities.

You can deploy the ATL from the mothership at any time. From the Flight menu, choose Deploy Lander to launch the ATL from the spacecraft that you are flying. From the Flight menu, choose Retract Lander to return the ATL to your original spacecraft.

Extremely popular with starship pilots, the ATL is the sports car of the fleet. Although the activity is officially frowned upon, the compact, well-powered, and highly maneuverable ATL is sometimes used for figure-eight racing between two space stations!

Mass	100 metric tons
Length	50 meters
Propulsion system	Chemical thrusters
Maximum acceleration	3 Gs
Fuel duration at maximum acceleration	45 minutes



Space Shuttle

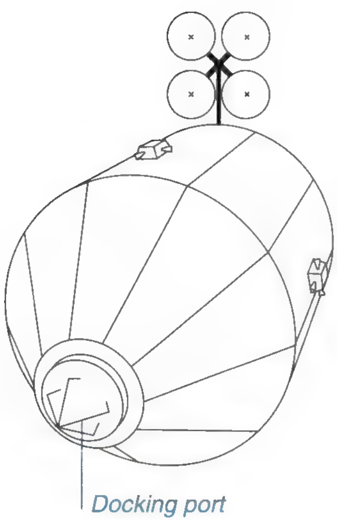
The space shuttle helped humans establish an initial foothold in space as the first reusable transport, capable of delivering up to 29,545 kilograms (65,000 pounds) of cargo into a low-Earth orbit of up to 1100 kilometers (684 miles).

The shuttle engines burn pressurized liquid hydrogen and liquid oxygen. Upon launch, the shuttle rides atop a large liquid-propellant tank and a pair of solid-propellant boosters. All three external tanks are jettisoned before the shuttle reaches orbital altitude, and the two smaller tanks are dropped by parachute (for recovery and reuse).

While in orbit, the doors of the shuttle's cargo bay are kept open to help radiate excess heat away from the craft. The doors are closed for reentry, during which time special tiles along the underside of the shuttle protect its aluminum skin from the extreme temperatures caused by atmospheric friction.

Mass	100 metric tons
Length	66 meters
Propulsion system	Chemical thrusters
Maximum acceleration	3 Gs
Fuel duration at maximum acceleration	8 minutes

Apollo Service Module

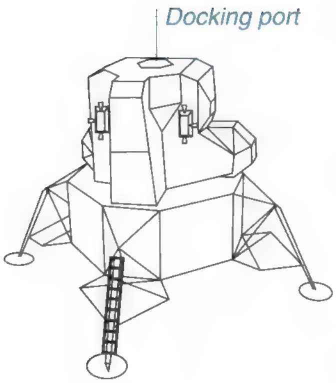


The Apollo service module is the spacecraft that remains in orbit about 111 kilometers (69 miles) above the lunar surface as the lunar excursion module undocks from it and descends to the Moon.

For the first Moon landing, on July 20, 1969, American astronaut Michael Collins commanded the Apollo service module (the Columbia), while Neil Armstrong and Edwin E. Aldrin Jr. descended in the lunar excursion module (the Eagle) to take humankind's first steps on the Moon.

Mass	30 metric tons
Length	10.4 meters
Propulsion system	Chemical thrusters
Maximum acceleration	2 Gs
Fuel duration at maximum acceleration	3 minutes

Lunar Excursion Module



The lunar excursion module (LEM) is the spacecraft you use to descend to the Moon's surface after undocking from the Apollo service module, which remains in orbit about 111 kilometers (69 miles) above the Moon's surface. Prior to undocking, the LEM and the Apollo service module are attached nose to nose.

American astronauts Neil Armstrong and Edwin E. Aldrin Jr. piloted a LEM called the Eagle to the Moon's surface and took the first steps there on July 20, 1969.

When you launch the LEM from the lunar surface to return to the Apollo service module, the LEM leaves its descent stage on the Moon to lessen its load.

Mass	16 metric tons
Length	9.45 meters
Propulsion system	Chemical thrusters
Maximum acceleration	1 G
Fuel duration at maximum acceleration	5 minutes

Manned Maneuvering Unit

The manned maneuvering unit (MMU) is a small self-contained unit that offers the most freedom in space. In 1984, American astronaut Bruce McCandless took the first untethered, self-propelled space walk in an MMU.

Whether you're flying a spacecraft or are docked to a space station, you can launch the MMU at any time for a space walk. From the Flight menu, choose Space Walk to launch the MMU. From the Flight menu, choose Reboard Craft to return the MMU to your spacecraft.

You need to be cautious about getting too far from your mothership. If you run out of fuel in an MMU, you might become a permanent fixture in space—rather like one of those moons that shows no sign of life.

Each time you reboard the mothership, Space Simulator automatically refuels your tanks.

Mass	200 kilograms
Length	2 meters
Propulsion system	Compressed nitrogen
Maximum acceleration	0.1 G
Fuel duration at maximum acceleration	30 minutes

Embarking on Multi-Ship Adventures

When you go out on an expedition, it's fun to transfer from one spacecraft to another to best meet your exploration strategies. For example, you can fly the Galactic Explorer from Earth orbit to an orbit around the Moon, and then deploy the all terrain lander (ATL) to descend to the lunar surface. At this point, you can try a space walk with the manned maneuvering unit (MMU).

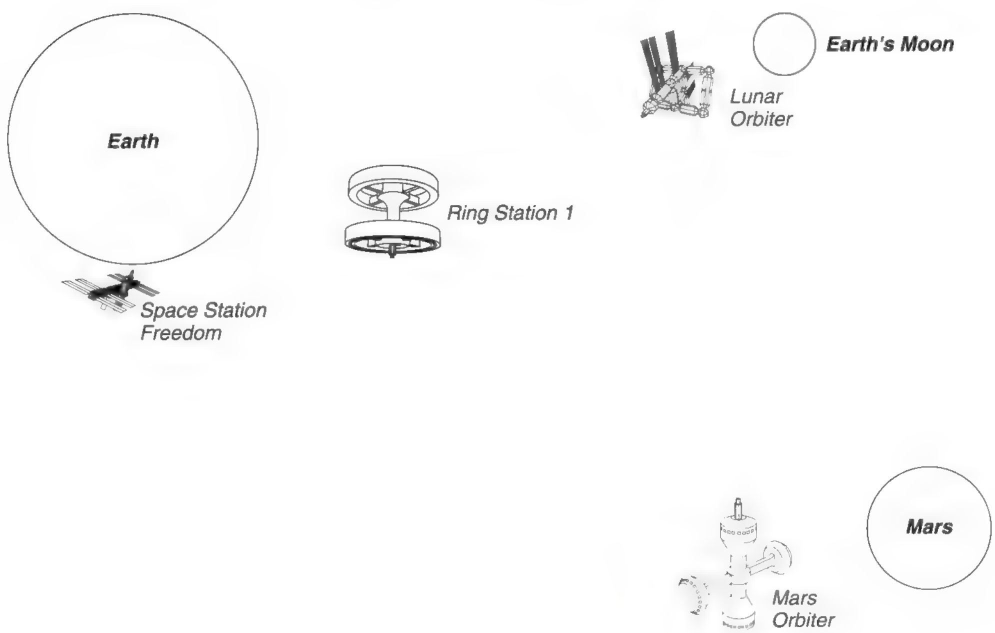
Each time you dock to a space station, Space Simulator automatically refuels your tanks.

You can embark on a similar multi-ship adventure by flying to Mars, or to one of Jupiter's moons, or by traveling to a different solar system. The procedures are the same: Use an interstellar spacecraft such as the Galactic Explorer, the Callisto, or the Zander Freighter to make the initial passage. Park the great ship in orbit around a moon or planet, and then deploy the ATL to descend to the surface. At any point along the way, you can take a space walk with the MMU.

For a step-by-step guide to a multi-ship lunar adventure, see "A Three-Stage Visit to the Moon" on page 158.

Visiting the Space Stations

There are different characteristics, as well as histories, for each of Space Simulator's space stations, and it's fun to actually fly these space stations from one location to another. For more information on flying space stations, see "Transferring Command to Ring Station 1" on page 91.



There are space stations in orbit around the Earth, the Moon, and Mars, just waiting for you to visit them.

To visit a space station

1. From the Location menu, choose Space Stations.

   Space Simulator displays the Space Stations dialog box.

2. From the list of available space stations, choose the one you want.

   Space Simulator displays a description of the space station.

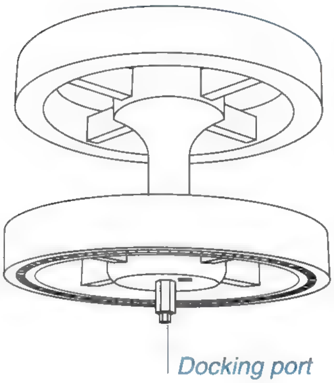
3. When you decide on the space station you want to visit, choose the OK button.

   Space Simulator returns you to spaceflight, positioned near the space station.

The list of available space stations can change depending on the situation. For more information on opening different situations, see the procedure "To open an existing situation" on page 98.

Now let's pay a visit and find out more about each of the space stations.

Ring Station 1



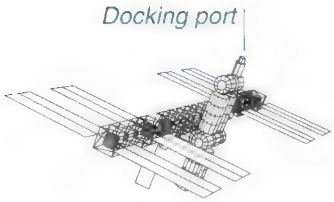
Docking port

Ring Station 1 is located at an altitude of 25,316 kilometers above the Earth's surface. It is popular with space travelers because its circular design and rate of rotation provide a 1-G environment, which is much appreciated by those living and working in space. The spokes of the station are used for medical and technological research because the nearer to the core of the station one goes, the less gravity is generated by the rotation. Much of one spoke is used as a low-gravity recovery unit for heart patients, while most of another is used as a popular hotel in which guests can choose their room location according to how much gravity they prefer.

Along the top of the station (or the ring facing away from Earth) is a large cargo bay. Test your star-pilot skills by trying to fly through it in either the ATL or the MMU.

Mass	500,000 metric tons
Length	1200 meters
Maximum acceleration	0.1 G

Space Station Freedom



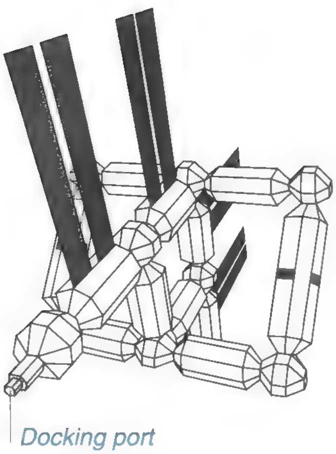
Space Station Freedom, initially delayed by funding problems, became the first major off-planet habitat for humanity. Located only 200 kilometers above the surface of the Earth, it was assembled from prefabricated parts carried into orbit by space shuttles as well as unmanned commercial carriers. Monthly correction burns (the brief application of thrust to change course) are required to maintain its low orbit.

Its solar panels, spreading like beautiful blue wings, generate more than enough power to keep the space station in operation.

You can only visit Space Station Freedom by choosing the Open Situation command from the Options menu, and then choosing 1999 or a SHTDOCK situation.

Mass	200 metric tons
Length	122.768 meters
Maximum acceleration	0.01 G

Lunar Orbiter

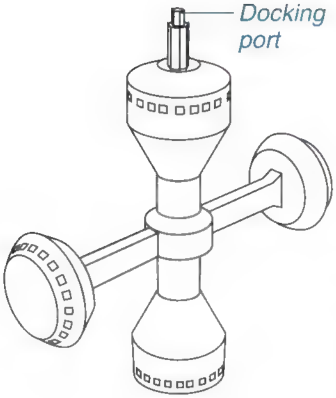


The Lunar Orbiter began as a construction shack for those building the first lunar surface colony, but kept growing to the point where it's now sometimes called "the maze." It was built one module at a time, making use of spent fuel tanks (for boosting cargo up from Earth). Rather than allowing the tanks to burn up during reentry, they were fitted with thrusters and sent over to lunar orbit.

Although the recycled cylinders were transported from low-Earth orbit to the building site 4100 kilometers above the Moon, using them still kept the cost of building materials low. However, construction workers, tired of drinking coffee from a tube instead of from a mug, are looking forward to completion of the lunar surface facilities. They're ready for some gravity to hold things in place.

Mass	200 metric tons
Length	400 meters
Maximum acceleration	0.1 G

Mars Orbiter



The Mars Orbiter is unusual in that it was constructed in low-Earth orbit, equipped with engines, and then flown to its Martian orbit. Although its propulsion system could only exert a fraction of a gravity, which made for slow going, it was a most comfortable and commodious ride for the delivery crew.

Now located 3389 kilometers above the surface of Mars, it served first as a critical staging area for the building of the first Martian surface colony. It continues to serve as a research facility, service station, and hotel, as well as an emergency facility should the life-support systems of the surface colony fail.

The centripetal force from the rotation of the Mars Orbiter provides a pleasant gravitational environment for the residential units and major work areas located along its perimeter.

Mass	300,000 metric tons
Length	1220 meters
Maximum acceleration	0.1 G

Chapter 8
Docking and Walking in Space

"On my first flight we had an EVA, a space walk. I didn't do it. But a couple of the other folks did. They loved it, because you can actually get into the cargo bay and really be a satellite. As a human being, the chance to be a satellite is a pretty unique experience."—Don Williams, American astronaut (from conversations with the Space Simulator team)

In this chapter, you'll learn how to

- Dock to a space station or with another spacecraft.
- Transfer control to the vehicle you've docked to.
- Undock and resume normal spaceflight.
- Leave your spacecraft and spacewalk in the manned maneuvering unit (MMU).

Way back in the summer of 1975, the world held its breath as an Apollo spacecraft from the United States and a Soyuz spacecraft from what was then the Soviet Union cautiously approached each other and then docked together in space. From July 15th through July 21st, these two spacecraft orbited as one as the crews shared meals, worked together on experiments, and transmitted this first-ever international docking back to television screens around the Earth.

It is bold enough to go into space, but the idea of rendezvousing with another object, and then docking to it, puts everything on the line. Think of the precision maneuvering that it requires, the inherent risk of a wrong move, and the intriguing adventure of it all.

With Space Simulator, all the demands and rewards of docking await you—and that's not all. You can go one step beyond and spacewalk.

Docking for the Fun of It

For more information on changing your skill level, see the procedure "To choose a skill level" on page 64.

Docking to a space station or spacecraft in Space Simulator is as exciting (and sometimes as demanding) as docking in outer space. However, if you set your skill level to practice or intermediate when you're learning the intricacies of docking, Space Simulator is more forgiving. When you know what you're doing, choose the advanced skill level and face all the challenges.

Each time you dock to a space station, Space Simulator automatically refuels your tanks.

Docking is fun—try it in time to the Blue Danube Waltz. For more information on playing background music while you fly, see "Choosing Sound Preferences" on page 66.

Docking to Ring Station 1

To make docking easier, Space Simulator includes a situation called DOCKING1. This situation opens with your spacecraft (the ATL) already aligned for docking with Ring Station 1. Let's give it a try.

When you open the DOCKING1 situation, your spacecraft is ready to dock to Ring Station 1—just add some thrust.

To dock to Ring Station 1

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Skill Level, verify that your skill level is set for practice, and then choose the OK button.

It's best to start docking at the practice level and then move on to the intermediate and advanced skill levels.

3. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

4. From the File Name list, choose DOCKING1, and then choose the OK button.

   Space Simulator displays your spacecraft aligned with the glowing orange docking port of Ring Station 1. Notice that Space Simulator displays the word "Slew" in the lower-right corner of the view window. Docking is easiest with the Slew Control command turned on.

   For more information on slewing, see "Slewing Through Space" on page 46.

5. Press the PAGE UP key two or three times to apply fine thrust.

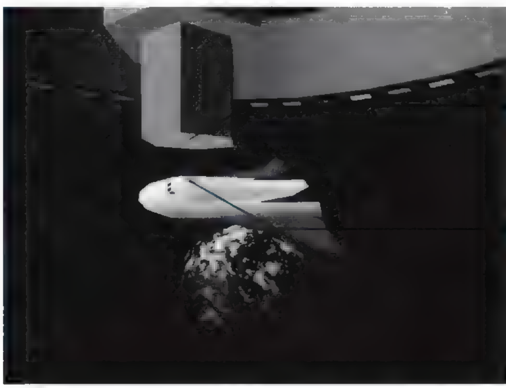
   Your spacecraft slowly rises toward the space station's docking port, locks onto the space station, and begins rotating at the same rate as the space station.

Congratulations! You've successfully docked the ATL and are now locked onto Ring Station 1.

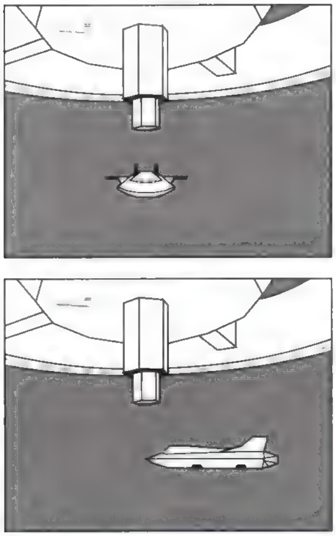
Preparing to Dock

If you want to transfer aboard a space station or another spacecraft without docking, you can use the manned maneuvering unit (MMU). For more information, see "Transferring with the MMU" on page 95.

Half the fun (and satisfaction) of docking is aligning your spacecraft with the docking port. Even when the Slew Control command is turned on, this takes skill and patience. The key is to use the panning bars to align your ship with the brightly lit docking port—panning first to a front view, then to a side view, and finally to a rear view. Once you've lined up the docking port using all three perspectives, you are ready to apply upward fine thrust and dock to the space station.



Every spacecraft has a brightly lit hexagonal docking port (each at its own custom location). Space station docking ports are always located along the central axis.



Pan to make sure that your spacecraft's docking port is aligned with the space station docking port. For more information on panning, see "Changing Your View Direction" on page 9.

To line up your spacecraft for docking

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose DOCKING2, and then choose the OK button.

   Space Simulator opens the situation with the Slew Control command turned on. You are viewing your spacecraft in Chase view. It looks as if your spacecraft is properly aligned with the space station's docking port, but it isn't.

3. Pan to the right (by pressing ALT+RIGHT ARROW or clicking the panning bar) so that you are looking at your spacecraft from the side.

   From this perspective, you can see how far your spacecraft is from the docking port. Note that you'll have to move forward to align your spacecraft with the docking port.

4. Pan until you can see the spacecraft's brightly lit docking port.

   If you keep your spacecraft's docking port visible, it will help you to line up with the space station's docking port.

5. Press KEYPAD PLUS SIGN to apply a small amount of forward thrust.

6. When the spacecraft's docking port is aligned with the space station's docking port, press the HOME key to stop all movement.

7. Pan until you are looking at the spacecraft from behind.

   From this perspective, you can check for left and right alignment between the docking ports.

8. Press the INSERT key to apply left fine thrust and move your ship to the left, if necessary. Press the DELETE key to apply right fine thrust and move your ship to the right, if necessary.

   Remember to use the vertical panning bar, if necessary, to keep your spacecraft's docking port in sight.

9. Pan horizontally or vertically (by pressing ALT+ the arrow keys or clicking the panning bar) to view your spacecraft from different positions and to verify alignment with the docking port.

   Since the skill level is set for practice, your alignment doesn't have to be perfect.

10. When your spacecraft's docking port is aligned with the docking port on the space station, press the PAGE UP key twice to apply fine thrust.

    When your ship locks into position, it will begin rotating with the space station.

If you want more docking practice, try the DOCKING2 situation again. When you get more confident, choose the FLIGHT situation and attempt

docking from a longer approach. Remember that docking is easiest when you turn on the Slew Control command.

Using the Docking-Port Camera

For a greater test of your docking skills, choose Preferences from the Options menu. Under Category, choose Skill Level, and then change the setting to either intermediate or advanced.

The docking-port camera—something that the big spacecraft of the future are certain to have—is a powerful tool to use when docking. When you turn it on, the Assigned view becomes the docking-port camera. This is especially important when you are flying Space Simulator with the skill level set to either intermediate or advanced, but even at the practice level the docking-port camera provides an exciting view.

To use the docking-port camera

1 From the Options menu, choose Open Situation.

Space Simulator displays the Open Situation dialog box.

2 From the File Name list, choose DOCKING2, and then choose the OK button.

Your spacecraft is in position for docking—a good time to play with the docking-port camera.

To display the menu bar from Full Screen View, press the ALT key or click the top of your computer screen.

3 From the Window menu choose View Controls.

Space Simulator displays the View Controls dialog box.

4 Under Assigned View, make sure that your Assigned view is Ring Station 1.

5 Under the Assigned View button, choose Docking Port Camera.

The check box indicates when the docking-port camera is turned on.

6 Choose the OK button.

The docking-port camera is now turned on—it is your new Assigned view.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

7 Press the S key or click the Location button to cycle to Assigned view, and press the D key or click the Direction button to cycle to Panning mode.

You are now looking through the space station's docking-port camera.

8 Press the PAGE DOWN key a few times to apply fine thrust and move away from the docking port.

You can also watch your spacecraft as you dock by setting the Assigned view as your spacecraft and turning on the docking-port camera.

Through the docking-port camera, you can watch your spacecraft move away from Ring Station 1.

9 Press the HOME key to stop your spacecraft's fine thrust so you don't get too far away from the space station.

10 Press the PAGE UP key a few times to apply fine thrust and move toward the docking port.

Watch as your spacecraft approaches and docks.

Make sure that you switch to Panning mode for a good view of your docking procedures. Just press the D key or click the Direction button on the view tools.

Have fun with the docking-port camera! If you keep your spacecraft well centered through the docking-port camera, you'll be able to dock more precisely. Press the S key to cycle from Assigned view to Chase view and perfect your alignment.

Matching Rotation with Ring Station 1

Choose the Save Situation command from the Options menu to make incremental saves as you line up your spacecraft for docking. This way you can quickly recover from navigational mistakes and you won't have to start all over again. For more information on the Save Situation command, see "Getting Yourself into Great Situations" on page 97.

You'll feel like a seasoned astronaut if you can match the rotation of your spacecraft with the rotation of the space station prior to applying fine thrust for the docking maneuver. In real spaceflight, if you don't match the rotation of the station prior to docking, your spacecraft is exposed to severe inertial stresses. Space Simulator doesn't require that you match rotation, even at the advanced skill level, but it is still fun to do. To rotate your spacecraft, simply press the LEFT ARROW key or the RIGHT ARROW key, depending on the rotational direction of the space station and the position of your spacecraft's docking port.

To match the spin of the space station

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the File Name list, choose DOCKING2, and then choose the OK button.

   Space Simulator opens the situation with the Slew Control command turned on. You are viewing your spacecraft in Chase view. It looks as if your spacecraft is properly aligned with the space station's docking port, but it isn't.

3. Press the LEFT ARROW key on the keypad once to start yawing your spacecraft to the left.

   Go easy. The point is to synchronize your rotational speed with the rotational speed of the space station. Press the LEFT ARROW key again if your spacecraft needs more rotational speed. Press the RIGHT ARROW key to decrease your spacecraft's rotational speed.

4. Press PAGE UP twice to apply fine thrust.

   Sit back and enjoy the view of your spacecraft moving into docking position with correct rotational velocity.

After you apply upward fine thrust, choose the Save Situation command from the Options menu to capture your docking action.

Matching your spacecraft's rotation with the docking object makes you feel like an absolute professional every time. It's an enjoyable way to set up your docking experiences.

Transferring Command to Ring Station 1

In Space Simulator, you actually get to take over the flight controls of the new object you've docked to. What a payoff for docking successfully!

For example, when you dock your spacecraft to Ring Station 1, you can start piloting the station. It won't be the fastest or most responsive vehicle in the fleet—think of it as driving a floating office building—but it can certainly be fun to move one of these giants and reposition it wherever you want.

You can always tell which vehicle you are currently controlling—just choose Spacecraft from Flight menu, and check under Current Spacecraft.

I *Press to display the instrument panel or make it active.*

To take command of the space station

1. Use your docking skills and dock to Ring Station 1 (or to any other object, such as another space station or spacecraft).

   Make sure you are securely locked onto the docking port.

2. From the Flight menu, choose Vehicle Transfer.

   Space Simulator transfers your flight controls—you can now pilot the space station to which you have just docked. The instrument panel remains the same but your thrust and rotation controls are less responsive than those of a spacecraft. For example, when flying a space station you can accelerate at only a fraction of a single G.

3. Press KEYPAD 5 to stop rotation of the space station.

   Halting rotation of the space station makes it easier to apply thrust in a single direction. (However, the people aboard the space station might not be happy, as the loss of rotation removes their artificial gravity and their toast will float out of the toaster!)

4. Press KEYPAD PLUS SIGN to apply thrust and begin to fly the space station.

   It won't move fast, but it will move—towing your docked spacecraft with it.

Transferring Back to Your Spacecraft and Undocking

The Vehicle Transfer command on the Flight menu is a powerful and enjoyable tool. Once you dock, you can use it to transfer your flight controls from one spacecraft or space station to another.

When you begin to miss your old spacecraft, or for any other reason decide it's time to leave the space station behind and again head out on your own, Space Simulator makes the process easy.

To return to your spacecraft and undock from the space station

1. From the Flight menu, choose Vehicle Transfer.

   Space Simulator transfers the flight controls back from the space station to your spacecraft. Check the thrust gauge to make sure there is no thrust remaining from your previous docking maneuver.

Shift + U

You can also press these keys to undock from a spacecraft or space station.

2. From the Flight menu, choose Undock.

   Your spacecraft is no longer docked to the space station. However, until you apply thrust or change your rate of rotation, you will continue to rotate at the same rate as the space station and still appear to be docked.

3 Press KEYPAD 5 to stop rotation, if necessary.

Your spacecraft stops rotating, but the space station continues at its rotational speed.

4 Press PAGE DOWN to get some distance from the space station docking port, and then press KEYPAD PLUS SIGN to apply thrust.

Wave good-bye, and head out on a new adventure!

Abandoning Your Spacecraft

It sounds kind of scary and very chilling, but once you transfer control to the space station or any other docking object, you can choose Undock from the Flight menu and separate yourself from your spacecraft. In this manner you can take the space station for a spin, and then come back later, ready to reboard your spacecraft.

To abandon your spacecraft

1 From the Options menu, choose Open Situation.

Space Simulator displays the Open Situation dialog box.

2 From the File Name list, choose DOCKING1 (or another situation of your choice), and then choose the OK button.

3 Dock to the space station, or another docking object.

If you need a quick review of the docking procedure, see the procedure "To dock to Ring Station 1" on page 87.

4 From the Flight menu, choose Vehicle Transfer.

You have now transferred the flight controls to the space station.

5 From the Flight menu, choose Undock.

By undocking without transferring back to your spacecraft, you'll find yourself aboard the space station but your spacecraft is no longer docked.

6 Press KEYPAD PLUS SIGN to apply thrust and fly the space station away from your spacecraft.

Redocking to your abandoned spacecraft When you abandon your spacecraft, you can use the thrust and rotation controls to maneuver the space station up to the docking port of the spacecraft. This takes skill and patience because the space station isn't nearly as maneuverable as your spacecraft. Using the Slew Control command makes it easier.

Using the Spacecraft command to reboard If you find it frustrating to chase down your spacecraft with your space station, you can always go to the Flight menu, choose Spacecraft, and, from the list box, choose the spacecraft that you abandoned. Space Simulator transfers your flight controls back to the spacecraft.

Moving a Space Station with the Location Menu

When you transfer your flight controls to a space station and want to get to a new location in a hurry, you can do so with the Location menu. This

is an ideal way for quickly transporting huge space stations around the solar system and beyond.

If life gets lonely around the Moon, move another space station there.

To move a space station with the Location menu

If you need a quick review of the docking procedure, see the procedure "To dock to Ring Station 1" on page 87.

1. Dock to a space station or to another docking object.
2. From the Flight menu, choose Vehicle Transfer.

   Space Simulator transfers the flight controls from your spacecraft to the space station.
3. From the Location menu, choose your new destination.

   For example, choose Planets, choose Mars from the list, and then choose the OK button.

Presto! Space Simulator moves your space station to the new location. If you want to move it next to another space station, choose Space Stations from the Location menu, and then choose the space station you want.

Walking in Space with the MMU

Perhaps the most daring and exciting feats in space have been those that involved walking in space with a manned maneuvering unit, or MMU. Because there is no tether on the MMU in Space Simulator, you are on your own when you choose to leave your spacecraft. Proceed with caution, but also with a great sense of adventure.

Leaping into Space

You can leap into space for a space walk in the following ways.

Shift + W

You can also press these keys to spacewalk or reboard your spacecraft.

To begin a space walk

▶ From the Flight menu, choose Space Walk.

Space Simulator sets you up in an MMU just outside the docking port of the spacecraft (or space station if you are docked), moving away from it at 1 meter per second. Press the S key or click the Location button on the view tools to switch to Chase view, and use the PLUS key or click the Plus button on the view tools to zoom in for a better view.

To end a space walk

▶ From the Flight menu, choose Reboard Craft.

You can also be more adventurous and fly your MMU back to your spacecraft's (or space station's) docking port. To make this process easier, use the Slew Control command.

Transferring with the MMU

When you are flying toward a space station in the MMU (in Cockpit view), you can turn on the head-up display to help you fly straight to the station. For more information, see "Using the Head-Up Display" on page 69.

The MMU is a tremendous vehicle for transferring aboard a space station or another spacecraft without taking the time to position your spacecraft and dock. It can also be a more dashing and daring way to make a visit.

Instead of aligning two docking ports, all you need to do is head your MMU for the new docking port and fly into it. If you choose Cockpit view, you can look through the helmet of your MMU as you travel.

To board a spacecraft or space station using the MMU

1 Fly your spacecraft into the vicinity of a docking port. You can fly to the docking port of a space station or to the docking port of another spacecraft. The closer you get, the less distance you'll need to cross with the MMU.

Y *Press to turn slew control on or off.*

2 Remember to turn on the Slew Control command to make flying easier.

3 When you get close enough to the docking port, press HOME to stop your spacecraft's velocity.

4 From the Flight menu, choose Space Walk or press SHIFT+W to start your space walk.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

5 Press the S key or click the Location button on the view tools to cycle to Chase view, and use the PLUS key or click the Plus button on the view tools to zoom in for a better view.

6 Press KEYPAD PLUS SIGN to apply thrust to the MMU and move toward the docking port of the spacecraft or space station.

7 Press the S key or click the Location button on the view tools to cycle back to Cockpit view so you can look through the helmet of the MMU while you head for the brightly lit docking port.

8 From the Window menu, choose View Controls.

Space Simulator displays the View Controls dialog box.

9 Under View Controls For Window, choose View 2.

10 Under View Location, choose Assigned, and then choose the Assigned view button.

Space Simulator displays the Select Assigned View Location dialog box.

11 Under Object Type, choose Space Stations, choose Ring Station 1 from the list, and then choose the OK button.

Space Simulator returns you to the View Controls dialog box.

12 Under the Assigned View button, turn on the Docking Port Camera.

13 Under View Direction, choose Panning, and then choose the OK button.

Space Simulator returns you to spaceflight.

14 From the Window menu, choose Show View 2.

Now you can watch the progress of your MMU from two different perspectives. View 1 shows your approach to the docking port in Cockpit view, while View 2 shows your approach through the docking-port camera.

When you venture out in the MMU, you experience space on the most human scale. Your spacecraft, the space stations, and the moons and planets seem all the more vast when you are out exploring in the MMU.

Use the MMU to make your journeys more dramatic.

Chapter 9
Recording Your Adventures

"From space I saw Earth—indescribably beautiful with the scars of national boundaries gone."—Muhammad Ahmad Faris, Syrian astronaut (from The Home Planet)

In this chapter you'll learn how to

- Fly and save situations.
- Take photographs of space.
- Record, edit, and play videos of your adventures.

When men and women first ventured into space, they returned with invaluable photographs and films of their experiences. It was through these captured images that the rest of humanity was able to glimpse the heavens. Space Simulator's world parallels the real world of space—a realm of vast and unexplored territories. As you travel through our galaxy, you, too, can bring back treasures.

Space Simulator provides three ways to capture and revisit your favorite finds.

Situations Besides flying ready-made situations to other planets, stars, or observatory sites, you can create your own. With the Save Situation command on the Options menu, you can save your position and time in space, the sights you are seeing, the spacecraft you are flying, and then return later to relive the adventure and continue your explorations.

Space Photographs With the Camera command on the Options menu, you can capture any image—a planet, an asteroid, a space station, a space walk—and bring it back to show your friends on Earth. Paste your photograph of Saturn into a letter home, or brag about your accomplishments by "wallpapering" a photo of Alpha Centauri on your computer screen.

Video Recorder With the Video Recorder command on the Options menu, you can record action sequences of spacecraft maneuvering, planets spinning, or comets flying by. Then you can watch them or play them for your friends.

Getting Yourself into Great Situations

Space Simulator offers a choice of ready-made situations to test your skills. You can jump into the shuttle cockpit and experience the

turbulence of an atmospheric reentry. You can land your spacecraft at Kennedy Space Center. You can orbit the Moon 300 kilometers above its surface. The Open Situation dialog box includes a wide range of spaceflight- and observatory-based situations. In addition, you can design your own situations and save them. For example, you can create a situation for carrying imaginary snowplow blades to Pluto, and happily relive that same mission on a hot summer day.

The Open Situation command is like a launching pad, from which you can blast into a situation anywhere within Space Simulator.

To open an existing situation

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. Under Show, choose the options you want. You can choose one or more, depending on which situations you want to see. If you choose all four options, Space Simulator displays all available situations.

   - Choose Flight Situations if you want to display spaceflight situations in the File Name list.
   - Choose Observatory Situations if you want to display observatory-based situations in the File Name list.
   - Choose Product Situations if you want to display the ready-made situations that are included in Space Simulator.
   - Choose My Situations if you want to display the situations that you have created and saved.

3. Under File Name, choose the situation you want to fly.

   Take a look at the Description box to see exactly what the situation offers.

4. Under Startup Situation, choose the Select button if you want to save a situation as the startup situation and start this situation every time you start Space Simulator.

   Space Simulator displays the name of the startup situation above the Select button.

5. Choose the OK button.

   Space Simulator starts the situation of your choice.

You can also delete any situation from the File Name list. Just choose the situation you want to delete, and then choose the Delete button.

Now that you know how to open the situation you want, Space Simulator's Reset Situation command on the Options menu will come in handy when you're practicing a maneuver. It resets your current situation. For example, if you want to practice docking to a space station until you can do it perfectly, choose Reset Situation each time you want to start over.

To reset a situation

Ctrl + Esc

Press to reset a situation.

▶ From the Options menu, choose Reset Situation.

Space Simulator immediately resets your current situation at the beginning.

Space Simulator's Save Situation command on the Options menu encourages you to save situations and lets you review them whenever you want. You can relive past expeditions and launch new ones using saved situations as stepping stones. Each situation you save makes your Space Simulator world richer and more personal.

The Save Situation dialog box is like an intergalactic passport. The situations you create will take you anywhere you want to go, letting you arrive in the spacecraft of your choice with all the parameters set to your specifications.

When you save a situation, Space Simulator saves the following information and settings with it:

- Your location in space
- Your view location
- Your view direction
- Your spacecraft
- All instrument panel settings

To save a new situation

1. First, create a situation you would like to save. Choose a spacecraft and location, and then fly to a destination, orbit, or land.

   For example, choose a spacecraft (Galactic Explorer) from the Flight menu, choose a star (Our Sun) from the Location menu, and begin a solar orbit about 2.7 million kilometers from the core of our Sun.

Press the SEMICOLON key to save a situation.

2. From the Options menu, choose Save Situation.

   Space Simulator displays the Save Situation dialog box.

3. In the File Name box, type a name for your situation.

   You can use up to eight letters for the name. Space Simulator automatically adds the .STN extension for a situation.

4. In the Directory box, type a path.

   If you don't type a path, Space Simulator automatically saves your situation in the SPACESIM directory.

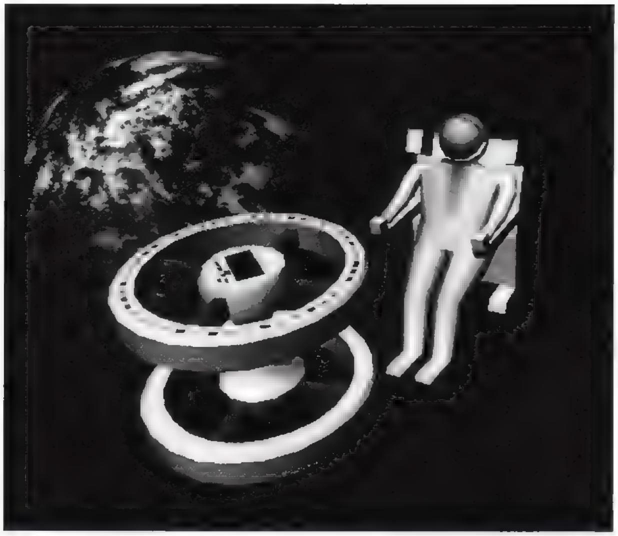
5. In the Description box, type a description for your situation.

   You can type up to 256 characters.

6. Choose the OK button.

   Space Simulator saves the new situation for you. The next time you choose Open Situation from the Options menu, you'll find your new situation in the File Name list.

Photographing the Wonders of Space



Photographs first brought the treasures of space back to the home planet for the human eye to marvel at. In Space Simulator, you, too, can capture images and immortalize your space travels. You can print your photographs, paste them in important documents, or display them for all the world to see.

Let's try taking a space photograph. In this example, we'll photograph the manned maneuvering unit (MMU). Anyone brave enough to go out into space in an MMU deserves to have their picture taken.

To photograph a space walker

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. Under File Name, choose MMU1, and then choose the OK button.

   Space Simulator sets you up in the MMU next to a space station. You are in Full Screen View.

3. Press the PAGE UP key, the PAGE DOWN key, the INSERT key, or the DELETE key to apply fine thrust (you can also use the mouse or joystick) and maneuver the MMU into any position you like.

You can also press the PRINT SCREEN key to take a space photograph.

4. From the Options menu, choose Camera.

   Space Simulator displays the Camera dialog box.

5. In the File Name box, type a name for your photograph.

   For example, type **walk**

To wallpaper your computer screen with a space photo, first copy the .BMP file into the directory where Microsoft Windows is located. Then, in Program Manager, choose the Control Panel icon, and then choose the Desktop icon. Under Wallpaper, choose the .BMP file that you want, and then choose the OK button.

6 Choose the file type you want:

- Choose the .BMP option to save the photograph as a bitmap so you can use the image as desktop "wallpaper" in Microsoft Windows.
- Choose the .PCX option to save the photograph as a .PCX file.

  You can view .BMP or .PCX files using Microsoft Windows Paintbrush or another graphics program. For more information, see the Paintbrush chapter in the *Microsoft Windows User's Guide* or the documentation for the graphics program that you are using.

7 In the Directory box, type a path.

If you don't type a path, Space Simulator automatically saves your space photograph in the SPACESIM directory.

8 Choose the OK button.

Space Simulator saves the photograph as a .BMP or .PCX file.

Recording and Playing Videos

You can direct your own space-travel videos using the Video Recorder command on the Options menu. Capture footage of your own perfect precision dockings, your smoothest lunar landings, or your most spectacular planetary flybys. Preserve all your adventures on video and set up private screenings for your friends.

To record a video

1 From the Options menu, choose Video Recorder.

Space Simulator displays the Video Recorder dialog box.

For information on how to edit your video as you record, see "Video Tips" on page 103.

2 In the File Name box, type a name for your video.

You can use up to eight letters for the name.

3 In the Directory box, type a path.

If you don't type a path, Space Simulator automatically saves your video in the SPACESIM directory.

4 In the Description box, type a description of your video.

5 Under Region To Record, choose the option you want:

- Choose Active Window to record only in the active window. This option creates the smallest recording area because only the active window is recorded.

R *Press to start recording a video.*

- Choose Full Screen View to record in full screen view (no menu bar or view tools—just the vastness of space).
- Choose Entire Screen to record everything on your screen, including multiple windows, the instrument panel, and the view tools. This is the only option that lets you change the arrangement of windows during recording.

At this point you can also press the Close button and return to set up the shoot. Once the stage is set just the way you want it, start recording.

6 Choose the Record button.

Space Simulator starts recording and updates the frame count and file size of your video in the upper-left corner of the view window. Note that when you're recording, a video file can grow quickly. Make sure your recording doesn't exceed remaining disk space.

| \ *Press to stop recording or playing a video.*

7 Press the BACKSLASH (\) key to stop recording.

Space Simulator stops the recording and returns you to spaceflight. For information on how to play the video you just recorded, read on.

To play a video

1 From the Options menu, choose Video Recorder.

Space Simulator displays the Video Recorder dialog box.

2 Under File Name, choose the video you want to play.

When you choose a video, note that the Description box reflects the display resolution, frame rate, file size, and view window in which the video was recorded. Make sure that the resolution is the same when recording and playing a video.

You can also type a description of the video in the Description box.

3 Choose the Looping Playback check box if you want the video to start from the beginning again after it's over.

P *Press to play a video.*

4 Choose the Play button.

Space Simulator starts the video and returns you to spaceflight when the video is over.

| \ *Press to stop recording or playing a video.*

5 Press the BACKSLASH (\) key to stop the video in progress and return to spaceflight.

To delete a video

1 From the Options menu, choose Video Recorder.

Space Simulator displays the Video Recorder dialog box.

2 Under File Name, choose the video you want to delete.

Review the Description box to make sure that you don't delete the wrong video.

3 Choose the Delete button.

Space Simulator displays the message "Delete video recording?"

4 Choose the OK button to delete the video.
–or–
Choose the Cancel button to return to the Video Recorder dialog box without deleting the video.

5 Choose the Close button to return to spaceflight.

Video Tips

Once you've mastered the basics, here are some easy ways to get the most from Space Simulator's video recorder.

Shortcut keys Remember, you can make video recording easy with four powerful keystrokes:

- Press the R key to begin recording a video.
- Press the BACKSLASH (\) key to stop recording or playing a video.
- Press the P key to play a video.
- Press the U key to pause and resume a video.

Editing your video recordings You can edit videos while you are recording by choosing Video Recorder from the Options menu, and then choosing the Pause button. Pause the action while you alter your location, vantage point, or close one situation and open another. Then continue recording by choosing the Pause button again.

U *Press to pause or resume a video recording.*

For example, begin your recording with a Cape Canaveral launch situation. Choose Video Recorder from the Options menu, choose the Pause button, close the Cape Canaveral situation, and open a low-Earth orbit situation in which the shuttle approaches a space station. Next, close the low-Earth orbit situation and open a reentry situation in which the shuttle returns to Earth. In this way, you can splice together one great video of a shuttle mission.

Note that when you include two or more situations in the same recording, the situations must have the same view window configuration. For example, if you begin your recording in full screen view, and then pause the action to edit in a second situation, you must also record the second situation in full screen view.

Monitoring the recording information When you are recording, Space Simulator displays the recording frame and the file size of your video in the upper-left corner of your screen. When you stop recording, Space Simulator no longer displays this information.

Note that when you're recording, a video file can grow quickly. Make sure your recording doesn't exceed remaining disk space.

For more information on increasing or decreasing the passage of time, see "Playing with Time" on page 34.

Playing with time The video recorder bases its recording rate on the figure of 15 frames per second, but you can record your video as fast or as slowly as you like by adjusting the time scale on the instrument panel. You can accelerate the passage of time by pressing F1. Each time you press F1, the passage of time is doubled. You can slow the passage of time by pressing F2. Each time you press F2, the passage of time is halved. Note that the time scale, in the lower-left corner of the instrument panel, reflects the rate of time.

For more information on how to visually enhance the Space Simulator experience, see "Adjusting Rendering Preferences" on page 60.

*For more information on SMARTDrive, see your MS-DOS User's Guide or type **help smartdrv** at the MS-DOS prompt to get online help.*

Adjusting image complexity Image complexity gets a free ride with the video recorder. If you choose Preferences from the Options menu, choose the Rendering option, and then, under Detail, choose Complex, your display rate is not affected during video playback (even though it may be affected during recording).

Making smoother recordings When you choose Video Recorder from the Options menu, and then choose the Looping Playback check box, your videos will be smoother. However, this suggestion only applies if you have a disk-caching program, such as SMARTDrive (available with MS-DOS). To enhance the video playback, make sure the video recording is shorter than the size of the disk cache.

"The Weather is Out of This World! Wish You Were Here!"

Have fun creating situations, photographing space, and recording your adventures on video! You can use these great Space Simulator features as intergalactic passports, postcards, and movies. Keep your travels to this celestial frontier on record or share them with others. You are breaking new ground with every voyage.

Chapter 10
Flying with the Autopilot

"Space is so close: It took only eight minutes to get there and twenty to get back."—Wubbo Ockels, Dutch astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Use the autopilot to automate your spacecraft controls.
- Choose from 15 autopilot actions—launch from any surface, apply thrust, establish and alter orbits, land, and more.

The time has come to introduce you to an invaluable flight companion. The Autopilot command on the Flight menu is a simple yet powerful tool for spaceflight. You can use it to orient your spacecraft toward a specific destination, orbit a planet, dock at a space station, land anywhere you want, and more.

For more information, see "Creating a Flight Plan with the Flight Computer" on page 119

With the autopilot, you can automate 15 important actions. Although the autopilot stores and executes only one action at a time, you can link several autopilot actions together into a complete flight plan using the flight computer. When you execute an autopilot action, watch for confirmation of the action in the lower-left corner of your viewing window, and remember that the autopilot automatically adjusts the time scale to execute maneuvers as quickly as possible.

Orienting Your Spacecraft

Choose Orient to point your spacecraft toward any object. For example, if you want to fly to Earth's Moon, but don't know where it is, you can use the autopilot to set your destination for Earth's Moon and orient your spacecraft to head straight for it. All you need to do is add thrust and the autopilot takes care of the rest.

To orient your spacecraft toward Earth's Moon

1. From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

2. Under Action, choose Orient.

   With this action, you set your spacecraft's orientation.

3 Choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

4 Under Object Type, choose Moons.

Space Simulator displays a list of all the available moons.

5 From the list, choose Earth's Moon (noting the information in the Description box), and then choose the OK button.

Space Simulator returns you to the Autopilot dialog box and verifies that Earth's Moon is your current destination.

6 Note that under Update, Space Simulator displays two check boxes: Reference Object and Tracking Object.

- When you turn on the Reference Object check box, Space Simulator updates the reference display on the instrument panel to show the current destination, as well as your distance from it.
- When you turn on the Tracking Object check box, Space Simulator updates the tracking object to your new destination.

7 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want to orient your spacecraft immediately toward Earth's Moon.

Z *Press to turn the autopilot on or off.*

When you execute this action, the autopilot is in control until your spacecraft is oriented. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

Turning Your Spacecraft Around

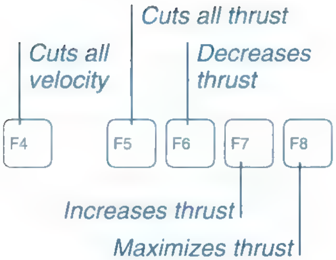
When you choose Turnover, the autopilot reverses the direction of your spacecraft so you can use the engines to reduce or increase velocity.

Choose Turnover to reverse the direction of your spacecraft. This action is especially important when flying in Flight Control, as opposed to Slew Control, because the only way you can stop a spacecraft in the vacuum of space is to reverse its direction and then apply an equal amount of thrust (as was used on the first part of the journey) for an equal amount of time. For example, a classic trip to Mars involves applying thrust for perhaps four minutes, and then coasting the rest of the way to Mars. Just before your arrival, use the autopilot to turn the spacecraft around and apply thrust for another four minutes in the opposite direction to cancel the previous thrust. Remember—once you execute a turnover, it is up to you to apply whatever thrust you need to slow or halt your current velocity.

To reverse the orientation of your spacecraft

S *Press to cycle through Cockpit, Chase, and Assigned views.*

1 On the view tools, choose the Location button and cycle to Chase view so you can watch the autopilot execute a turnover.



2 From the Flight menu, choose Autopilot.

Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

3 Under Action, choose Turnover.

With this action, you reverse the orientation of your spacecraft.

4 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want to reverse the direction of your spacecraft immediately.

When you execute this action, the autopilot is in control until your spacecraft is pointing in the reverse direction, and then it's up to you to apply thrust to slow your approach. The F4 through F8 keys are a handy way of controlling thrust and velocity, especially when you are flying with a joystick.

Establishing a Prograde or Retrograde Orientation

Prograde and retrograde adjustments are at the heart of orbital mechanics. However, you can also make prograde and retrograde adjustments while traveling in a straight line. For example, while making interplanetary or interstellar passages, you can choose a retrograde orientation so that your spacecraft is facing away from the reference object.

Choose Prograde to orient your spacecraft so that its nose is pointing in the same direction as the direction in which you are currently traveling with respect to the destination. Once your spacecraft is in a prograde orientation, you can apply thrust and increase velocity in the direction of your orbit—this increases the apogee of your orbit as well, moving you to a higher orbit.

Choose Retrograde to reverse your orbital direction so that the front of your spacecraft is facing away from its direction of travel. Once your spacecraft is in a retrograde orientation, you can apply thrust against your current direction and slow your speed. If you continue to apply retrograde thrust, you'll cancel your current velocity and begin to move in the opposite direction.

To establish a prograde or retrograde orientation in your orbit around Mars

1 From the Flight menu, choose Autopilot.

Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

Make sure you are in orbit before you attempt a prograde orientation.

2 Under Action, choose Prograde or Retrograde.

Depending on your choice, you orient your spacecraft in a prograde or retrograde direction.

3 Choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

4 Under Object Type, choose Planets.

Space Simulator displays a list of all the available planets.

5 From the list, choose Mars (noting the information in the Description box), and then choose the OK button.

Space Simulator returns you to the Autopilot dialog box and verifies that Mars is your current destination—or the planet around which you will establish either a prograde or retrograde orientation.

6 Note that under Update, Space Simulator displays two check boxes: Reference Object and Tracking Object.

- When you turn on the Reference Object check box, Space Simulator updates the reference display on the instrument panel to show the current destination, as well as your distance from it.
- When you turn on the Tracking Object check box, Space Simulator updates the tracking object to your new destination.

Z Press to turn the autopilot on or off

7 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want to orient your spacecraft immediately in a prograde or retrograde direction.

When you execute this action, the autopilot is in control until you establish a prograde or retrograde orientation, and then the controls are yours. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

Launching Your Spacecraft

Choose Launch to take off from any surface. With this autopilot action, Space Simulator places your spacecraft perpendicular to the horizon and applies thrust until the spacecraft reaches a velocity and an orientation sufficient to provide a circular orbit at the orbital radius that you specify. You can also specify a launch azimuth and send your spacecraft off at whatever angle you like.

The Launch maneuver is only available when your spacecraft is positioned on the surface of a planet, moon, or other object. To launch the shuttle from Cape Canaveral, choose Open Situation from the Options menu, and choose CAPEDUSK from the list of situations.

To launch your spacecraft

1 From the Flight menu, choose Autopilot.

Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

2 Under Action, choose Launch.

With this action, you launch your spacecraft and Space Simulator places you at an orbital altitude of approximately 300 kilometers.

3 Choose the Orbital Radius button to set your own orbital altitude.

Space Simulator displays the Orbital Radius dialog box.

When you set the orbital radius for 3 or 4 radii (distance from center), your spacecraft makes proportionally similar orbits, whether it is orbiting a tiny asteroid or a huge sun.

4 In the Altitude box, type the orbital radius you want (this figure refers to Altitude Above Surface).
–or–
Choose Distance From Center, and then type an orbital height in the Distance box.

Don't forget to choose an appropriate unit of measure (Kilometers, Million Kilometers, Astronomical Units, or Radii).

5 Choose the OK button.

Space Simulator returns you to the Autopilot dialog box and displays your orbital radius.

6 Under Launch Azimuth, type the angle for your launch.

The initial launch azimuth is 90 degrees because this angle positions your spacecraft for an equatorial orbit (in the direction of the Earth's rotation). You can change the launch azimuth to any number you want. For example, a 0-degree launch azimuth positions your spacecraft for a polar orbit (in the direction of the North Pole).

You can also press these keys to launch your spacecraft.

7 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want to launch your spacecraft immediately.

When you execute this action, the autopilot is in control until your spacecraft begins its orbit, and then the controls are yours. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

Orbiting

Choose Orbit to select a destination and enter into a stable orbit when you reach it. For example, you can set the autopilot to fly to Pluto and orbit the planet when you get there.

To orbit Pluto

1 From the Flight menu, choose Autopilot.

Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

2 Under Action, choose Orbit.

With this action, Space Simulator puts you in a stable orbit when you reach your destination.

3 Choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

4 Under Object Type, choose Planets, choose Pluto from the list (noting the information in the Description box), and then choose the OK button.

Space Simulator returns you to the Autopilot dialog box and verifies that Pluto is your current destination.

5 Note that under Update, Space Simulator displays two check boxes: Reference Object and Tracking Object.

- When you turn on the Reference Object check box, Space Simulator updates the reference display on the instrument panel to show the current destination, as well as your distance from it.
- When you turn on the Tracking Object check box, Space Simulator updates the tracking object to your new destination.

6 Choose the Orbital Radius button if you want to change Space Simulator's standard orbit.

Space Simulator displays the Orbital Radius dialog box.

When you set the orbital radius for 3 or 4 radii (distance from center), your spacecraft makes proportionally similar orbits, whether it is orbiting a tiny asteroid or a huge sun.

7 In the Altitude box, type the orbital radius you want (this figure refers to Altitude Above Surface).
–or–
Choose Distance From Center, and then type an orbital height in the Distance box.

Don't forget to choose an appropriate unit of measure (Kilometers, Million Kilometers, Astronomical Units, or Radii).

8 Choose the OK button.

Space Simulator returns you to the Autopilot dialog box and displays your orbital altitude.

9 Under Orbital Inclination, type the orbital angle you want (or use the initial setting of 90 degrees).

Orbital inclination refers to variation from the equatorial plane. An orbital inclination of 10 degrees means that the orbital plane intersects the equatorial plane at an angle of 10 degrees. A perfect equatorial orbit has an inclination of 0 degrees. A perfect polar orbit has an inclination of 90 degrees.

While executing an orbit with the autopilot, Space Simulator controls the time scale so that a trip to Alpha Centauri, for example, doesn't require that you sit in front of your computer for several years, centuries, or even millennia.

10 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want to send your spacecraft into orbit immediately.

When you execute this action, the autopilot is in control until your spacecraft is in an established orbit. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

Rendezvousing in Space

Choose Rendezvous to fly to an object and match its position and velocity, without entering into an orbit around it. For example, you can set the autopilot to take you to Comet Kohoutek, and then continue your journey.

To rendezvous with Comet Kohoutek

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

1. On the view tools, choose the Location button and cycle to Chase view so you can see Comet Kohoutek as you arrive.
2. From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.
3. Under Action, choose Rendezvous.

   With this action, the autopilot flies you to your destination.
4. Choose the Destination button.

   Space Simulator displays the Select Destination Object dialog box.
5. Under Object Type, choose Comets.

   Space Simulator displays a list of all the available comets.
6. From the list, choose Kohoutek (noting the information in the Description box), and then choose the OK button.

   Space Simulator returns you to the Autopilot dialog box and verifies that Kohoutek is your current destination.
7. Note that under Update, Space Simulator displays two check boxes: Reference Object and Tracking Object.

   - When you turn on the Reference Object check box, Space Simulator updates the reference display on the instrument panel to show the current destination, as well as your distance from it.
   - When you turn on the Tracking Object check box, Space Simulator updates the tracking object to your new destination.

While executing a rendezvous with the autopilot, Space Simulator controls the time scale so that a trip to Comet Kohoutek, for example, doesn't require that you sit in front of your computer for several years, centuries, or even millennia.

8. Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
   –or–
   Choose the Execute button if you want to rendezvous immediately with Comet Kohoutek.

   When you execute this action, the autopilot is in control until you rendezvous with your destination object. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

Automating the Docking Process

Choose Dock and the autopilot navigates your spaceship, and docks it, to a space station or another spacecraft.

To fly to Ring Station 1 and dock

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. Under File Name, choose FLIGHT, and then choose the OK button.

   Space Simulator sets you up with Ring Station 1 and the Earth out your cockpit window.

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

3. On the view tools, choose the Location button and cycle to Chase view so you can watch the autopilot dock your spacecraft to Ring Station 1.

4. From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

5. Under Action, choose Dock.

   With this action, the autopilot docks your spacecraft to a specified destination object.

6. Choose the Destination button.

   Space Simulator displays the Select Destination Object dialog box.

7. Under Object Type, choose Space Stations.

   Space Simulator displays a list of all the available space stations.

8. From the list, choose Ring Station 1 (noting the information in the Description box), and then choose the OK button.

   Space Simulator returns you to the Autopilot dialog box and verifies that Ring Station 1 is your current destination.

9. Note that under Update, Space Simulator displays two check boxes: Reference Object and Tracking Object.

   - When you turn on the Reference Object check box, Space Simulator updates the reference display on the instrument panel to show the current destination, as well as your distance from it.
   - When you turn on the Tracking Object check box, Space Simulator updates the tracking object to your new destination.

Z — *Press to turn the autopilot on or off.*

10. Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
    –or–
    Choose the Execute button if you want the autopilot to dock your spacecraft to Ring Station 1 immediately.

When you execute this action, the autopilot is in control until your spacecraft docks. Now try using the autopilot to undock. For a clear view of the Undock action, continue to watch in Chase view.

Undocking

For more information on the flight computer, see "Creating a Flight Plan with the Flight Computer" on page 119.

Choose Undock to detach your spacecraft from a space station or other spacecraft. This action is the same as the Undock command on the Flight menu, but Space Simulator offers it with the autopilot so that you can integrate it into a complete flight plan using the flight computer.

To undock from Ring Station 1

1. From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

2. Under Action, choose Undock.

   With this action, the autopilot undocks your spacecraft.

3. Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
   –or–
   Choose the Execute button if you want to undock from Ring Station 1 immediately.

⇧Shift + U

You can also press these keys to undock from a spacecraft or space station.

Transferring Control with the Autopilot

You can always tell which vehicle you are currently controlling—just choose Spacecraft from Flight menu, and check under Current Spacecraft.

Choose Vehicle Transfer to transfer control from your spacecraft to the space station or spacecraft you dock to. This action is the same as the Vehicle Transfer command on the Flight menu, but Space Simulator offers it with the autopilot so that you can integrate it into a complete flight plan using the flight computer.

To transfer command to Ring Station 1

1. From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

2. Under Action, choose Vehicle Transfer.

   With this action, the autopilot transfers control to the space station.

3. Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
   –or–
   Choose the Execute button if you want to transfer control to Ring Station 1 immediately.

⇧Shift + T

You can also press these keys to transfer control when you dock to another spacecraft or space station.

Walking in Space with the Autopilot

Choose Space Walk to deploy the manned maneuvering unit (MMU). This action has the same result as the Space Walk command on the Flight menu, but Space Simulator offers it with the autopilot so that you can integrate it into a complete flight plan using the flight computer.

To spacewalk with the autopilot

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. Under File Name, choose FLIGHT, and then choose the OK button.

   Space Simulator sets you up with Ring Station 1 and the Earth out your cockpit window.

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

3. On the view tools, choose the Location button and cycle to Chase view so you can watch your space walk.

4. Pan to the left so that you get a side view of the spacecraft and can see the manned maneuvering unit (MMU) as it descends from the docking port.

Shift + W

You can also press these keys to spacewalk or reboard your spacecraft.

5. From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

6. Under Action, choose Space Walk.

   With this action, the autopilot sends you out on a space walk in the MMU.

Use the PLUS key or click the Plus button on the view tools to zoom in for a better view.

7. Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
   –or–
   Choose the Execute button if you want to walk in space immediately.

   As soon as you execute this action, the MMU is out of the docking port—so get ready to take over the controls.

Deploying the Lander

Choose Deploy Lander to launch the all terrain lander (ATL). This action has the same result as the Deploy Lander command on the Flight menu, but Space Simulator offers it with the autopilot so that you can integrate it into a complete flight plan using the flight computer.

To deploy the all terrain lander

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2 Under File Name, choose FLIGHT, and then choose the OK button.

Space Simulator sets you up with Ring Station 1 and the Earth out your cockpit window.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

3 On the view tools, choose the Location button and cycle to Chase view so you can watch as the autopilot deploys the ATL.

4 Pan to the left so that you get a side view of the spacecraft and can see the ATL as it descends from the docking port.

5 From the Flight menu, choose Autopilot.

Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

Shift + D

You can also press these keys to deploy or retract the all terrain lander (ATL) from Space Simulator's four largest spacecraft.

6 Under Action, choose Deploy Lander.

With this action, the autopilot deploys the ATL.

7 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want to deploy the ATL immediately.

When you execute this action, the autopilot is in control until the ATL is away from the docking port, and then you take over the controls.

Setting Thrust

With the autopilot, Thrust means full thrust. The distances of space are so vast that the autopilot and flight computer assume you want full engine thrust for the specified duration.

Choose Thrust to apply maximum thrust for a given period of time.

To set thrust with the autopilot

1 From the Flight menu, choose Autopilot.

Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

2 Under Action, choose Thrust.

With this action, you can set the duration of thrust.

3 Choose the Duration button.

Space Simulator displays the Event Duration dialog box.

4 In the Duration box, type a time frame for the duration of thrust.

5 Choose the measurement you want (Seconds, Minutes, Hours, Days, Months, or Years), and then choose the OK button.

Space Simulator returns you to the Autopilot dialog box and confirms the duration of thrust.

Z Press to turn the autopilot on or off.

6 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want the autopilot to apply thrust immediately.

When you execute this action, the autopilot is in control and applies thrust for the specified duration. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

Coasting

Choose Coast to set a coasting period for your spacecraft. This is a wise and efficient way to travel because once you apply thrust to get your spacecraft up to speed, there is no friction within the huge vacuum of space to slow it down. Coasting is an excellent way to conserve fuel.

To coast with the autopilot

1 From the Flight menu, choose Autopilot.

Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

2 Under Action, choose Coast.

With this action, you can set the duration of the coasting action.

3 Choose the Duration button.

Space Simulator displays the Event Duration dialog box.

4 In the Duration box, type a time frame for the duration you want to coast.

5 Choose the measurement you want (Seconds, Minutes, Hours, Days, Months, or Years), and then choose the OK button.

Space Simulator returns you to the Autopilot dialog box and confirms the duration of the coasting period.

Z Press to turn the autopilot on or off.

6 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want the autopilot to begin coasting immediately.

When you execute this action, the autopilot is in control for the duration of the coasting period. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

Landing with the Autopilot

Choose Land and the autopilot flies your spacecraft to, and sets it down at the destination of your choice. For example, try landing the F-79 Galactic Fighter on familiar ground—our home planet.

To land on the Earth

1 From the Location menu, choose Space Stations.

   Space Simulator displays the Space Stations dialog box.

2 From the list, choose Ring Station 1, and then choose the OK button.

   Space Simulator sets you up with Ring Station 1 out your cockpit window.

3 From the Flight menu, choose Spacecraft.

   Space Simulator displays the Spacecraft dialog box.

4 From the list, choose F-79 Galactic Fighter, and then choose the OK button.

   You are now equipped for a landing on Earth.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

5 On the view tools, choose the Location button and cycle to Chase view so you can watch your spacecraft land.

6 From the Flight menu, choose Autopilot.

   Space Simulator displays the Autopilot dialog box. You now have a range of actions and destinations to choose from.

7 Under Action, choose Land.

   With this action, the autopilot lands your spacecraft at a specified surface destination.

8 Choose the Destination button.

   Space Simulator displays the Select Destination Object dialog box.

9 Under Object Type, choose Planets.

   Space Simulator displays a list of all the available planets.

10 From the list, choose Earth, and then choose the OK button.

   Space Simulator returns you to the Autopilot dialog box and verifies that the Earth is your current destination.

11 Note that under Update, Space Simulator displays two check boxes: Reference Object and Tracking Object.

   - When you turn on the Reference Object check box, Space Simulator updates the reference display on the instrument panel to show the current destination, as well as your distance from it.
   - When you turn on the Tracking Object check box, Space Simulator updates the tracking object to your new destination.

G *Press to extend or retract landing gear.*

12 Choose the Close button if you want to store this autopilot action and execute it later (when you are ready, all you have to do is press the Z key to execute the action).
–or–
Choose the Execute button if you want to begin an automated landing immediately.

When you execute this action, the autopilot is in control until your spacecraft lands. Watch the distance display as you get closer and closer to the Earth. To turn off the autopilot and manually control the instruments, press Z or click the autopilot status display on the instrument panel.

The autopilot becomes even more powerful when you use the flight computer to assemble individual autopilot instructions into complete flight plans. So, the flight computer is where we go next!

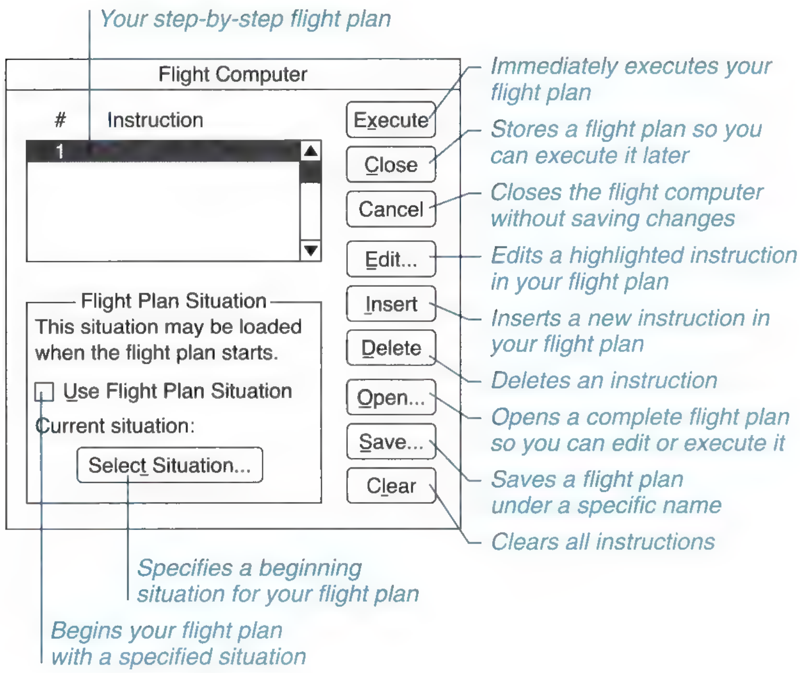
Chapter 11
Creating a Flight Plan with the Flight Computer

"The first day or so we all pointed to our countries. The third or fourth day we were pointing to our continents. By the fifth day, we were aware of only one Earth."—Sultan Bin Salman al-Saud, Saudi Arabian astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Create and edit a flight plan.
- Use a situation as the starting point for your flight plan.
- Use the flight computer for prograde and retrograde orientations.

The flight computer is a natural and powerful extension of the autopilot. You can use it to link one autopilot action after another into one smoothly executed flight plan. Another useful feature of the flight computer is that you can incorporate a situation as the starting point for your trip. Before creating your first flight plan, take a quick look at the flight computer:



Now it's time to use this invaluable tool to make a flight plan. Use your imagination to create a completely automated voyage from one end of our galaxy to the other—or beyond. It's like flying with a robotic copilot.

Creating and Editing a Flight Plan

Use the flight computer to create a simple flight plan—fly to Ring Station 1, and then leave it behind as you continue into space. Then modify your plan by inserting new instructions so that you fly to the Moon instead.

To create flight plan RINGER

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. Under File Name, choose FLIGHT, and then choose the OK button.

   Space Simulator places your spacecraft near Earth with Ring Station 1 just off to one side.

3. From the Flight menu, choose Flight Computer.

   Space Simulator displays the Flight Computer dialog box.

Each step that you add in the Instruction box contributes to the automated sequence of events that becomes your flight plan.

4. Choose the Edit button to start specifying instructions.

   Space Simulator displays the Instruction #1 dialog box so you can specify the first instruction in your flight plan.

5. Under Action, choose Orient, and then choose the Destination button.

   Space Simulator displays the Select Destination Object dialog box.

6. Under Object Type, choose Space Stations, choose Ring Station 1 from the list, and then choose the OK button.

   Space Simulator returns you to the Instruction #1 dialog box and displays Ring Station 1 as your current destination.

7. Choose the OK button.

   Space Simulator returns you to the Flight Computer dialog box and displays Orient as the first instruction in your flight plan.

8. In the Instruction box, choose line 2, and then choose the Edit button.

   Space Simulator displays the Instruction #2 dialog box.

9. Under Action, choose Thrust, and then choose the Duration button.

   Space Simulator displays the Event Duration dialog box.

10. In the Duration box, type **3** (make sure you choose Seconds), and then choose the OK button.

    Space Simulator returns you to the Instruction #2 dialog box and displays 3 seconds as the event duration.

So far, your flight plan includes orienting your spacecraft toward Ring Station 1 and applying thrust for 3 seconds.

Now your flight plan includes orienting your spacecraft toward Ring Station 1, applying thrust for 3 seconds, and reversing the direction of your spacecraft.

Your finalized flight plan will orient your spacecraft toward Ring Station 1, apply 3 seconds of thrust, reverse the direction of your spacecraft, and apply 3 seconds of thrust in the opposite direction to slow your spacecraft as it approaches Ring Station 1.

11 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Thrust as the second instruction in your flight plan.

12 In the Instruction box, choose line 3, and then choose the Edit button.

Space Simulator displays the Instruction #3 dialog box.

13 Under Action, choose Turnover, and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Turnover as the third instruction in your flight plan.

14 In the Instruction box, choose line 4, and then choose the Edit button.

Space Simulator displays the Instruction #4 dialog box.

15 Under Action, choose Thrust, set the duration for 3 seconds, and then choose the OK button.

Space Simulator returns you to the Instruction #4 dialog box and displays 3 seconds as the event duration.

16 Choose the OK button again.

Space Simulator returns you to the Flight Computer dialog box and displays Thrust as the fourth instruction in your flight plan.

17 Choose the Save button to save a your new flight plan.

Space Simulator displays the Save Flight Plan dialog box.

18 In the File Name box, type **ringer** (you can also type a description for your flight plan in the Description box; for example, type **A trip to Ring Station 1**), and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box.

19 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box.

20 Choose the Execute button if you want to execute your flight plan immediately (or choose the Close button if you want to store this flight plan and execute it later).

When you execute a flight plan, the autopilot is in control until your spacecraft carries out all the instructions. To turn off the autopilot and manually control the instruments, press Z or click the autopilot display on the instrument panel.

The journey using flight plan RINGER covers only a few kilometers, but you can change your destination and travel time with a few simple edits.

To edit flight plan RINGER

1. From the Flight menu, choose Flight Computer.

   Space Simulator displays the Flight Computer dialog box.

2. Choose the Open button, confirm that RINGER is in the File Name box, and then choose the OK button.

   Space Simulator displays flight plan RINGER in the Flight Computer dialog box.

3. In the Instruction box, choose line 1, and then choose the Edit button.

   Space Simulator displays the Instruction #1 dialog box.

4. Choose the Destination button.

   Space Simulator displays the Select Destination Object dialog box.

5. Under Object Type, choose Moons, choose Earth's Moon from the list, and then choose the OK button.

   Space Simulator returns you to the Instruction #1 dialog box and displays Earth's Moon as your current destination.

6. Choose the OK button.

   Space Simulator returns you to the Flight Computer dialog box and displays Orient as the first instruction in your flight plan, but you've changed the destination from Ring Station 1 to Earth's Moon.

7. In the Instruction box, choose line 2, and then choose the Edit button.

   Space Simulator displays the Instruction #2 dialog box.

8. Choose the Duration button, change the duration of thrust to 52 minutes, and then choose the OK button.

   Space Simulator returns you to the Instruction #2 dialog box and displays 52 minutes as the event duration.

9. Choose the OK button.

   Space Simulator returns you to the Flight Computer dialog box and displays Thrust as the second instruction in your flight plan, but you've changed the duration of thrust.

You'll now experience a full 4 Gs of acceleration for 52 minutes before the flight computer executes the Turnover instruction.

10. In the Instruction box, choose line 4 (skip line 3, because you want to leave the Turnover action as is), and then choose the Edit button.

    Space Simulator displays the Instruction #4 dialog box.

11. Choose the Duration button, change the duration of thrust to 52 minutes, and then choose the OK button.

    Space Simulator returns you to the Instruction #4 dialog box and displays 52 minutes as the event duration.

12 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box. Because you specified the Turnover action in line 3, the application of thrust in line 4 brings your spacecraft's velocity to a near standstill as you reach the Moon.

13 Choose the Save button.

Space Simulator displays the Save Flight Plan dialog box with RINGER in the File Name box.

14 In the File Name box, type a new name for your flight plan (for example, type **moon1**).

This saves the edited version of your flight plan as MOON1, and keeps the original flight plan as RINGER.

15 In the Description box, type a description for your new flight plan (for example, type **A quick trip to the Moon**), and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box.

16 Choose the Execute button to execute your flight plan (or choose the Close button if you want to store this flight plan and execute it later).

When you execute a flight plan, the autopilot is in control until your spacecraft carries out all the instructions—in this case, when you arrive at the Moon in about 104 minutes. To turn off the autopilot and manually control the instruments, press Z or click the autopilot display on the instrument panel.

Sit back and enjoy the journey. If you decide you want to spend some time coasting on your approach to the Moon, all you have to do is insert an additional instruction into your flight plan.

To insert an additional instruction into flight plan MOON1

1 From the Flight menu, choose Flight Computer.

Space Simulator displays the Flight Computer dialog box.

You can also delete a flight plan instruction. Just choose the instruction you want to delete, and then choose the Delete button.

2 Choose the Open button and confirm that MOON1 is listed in the File Name box, and then choose the OK button.

Flight Simulator displays flight plan MOON1 in the Flight Computer dialog box.

3 In the Instruction box, choose line 4 (the Thrust instruction), and then choose the Insert button.

Space Simulator inserts a blank line at line 4. Now you can insert a new instruction so that you can coast for a little while.

4 Choose the Edit button.

Space Simulator displays the Instruction #4 dialog box.

5 Under Action, choose Coast, and then choose the Duration button.

Space Simulator displays the Event Duration dialog box.

6 In the Duration box, type **7** (don't forget to choose Minutes as the unit of measure), and then choose the OK button.

Space Simulator returns you to the Instruction #4 dialog box and displays 7 minutes as the event duration.

7 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays your new five-step flight plan.

8 You can choose the Save button to update flight plan MOON1, or you can save it under a new name.

9 Choose the Execute button to execute your flight plan (or choose the Close button if you want to store this flight plan and execute it later).

Relax and enjoy the extra coasting action on your trip to the Moon! To turn off the autopilot and manually control the instruments, press Z or click the autopilot display on the instrument panel.

Using a Situation as the Starting Point for Your Flight Plan

Another powerful feature of the flight computer is that you can choose any already existing situation, or create a new one, as the starting point for your flight plan. Try it out—set the scene by creating a situation at Mars Base Marineris, and then build your flight plan from there.

To create a situation for your flight plan

1 From the Location menu, choose Surface.

Space Simulator displays the Surface Locations dialog box.

2 From the list, choose Mars Base Marineris, and then choose the OK button.

Space Simulator transports you to Mars Base Marineris.

3 From the Options menu, choose Time, or click the time display on the instrument panel, change the time and date to around 12:00:00 on August 31, 2020, and choose the OK button.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

4 On the view tools, choose the Location button and cycle to Chase view so you can watch your spacecraft as your flight plan unfolds.

B *Press to quickly switch between relative and absolute chase craft perspectives.*

5 Change the chase craft perspective to absolute for the most realistic view of your spacecraft.

With the absolute perspective, your spacecraft turns while the background remains constant. For more information on absolute versus relative perspective, see "Controlling Views" on page 16.

6 From the Flight menu, choose Spacecraft, choose the All Terrain Lander, and then choose the OK button.

The ATL is a good spacecraft for a surface-based mission such as this.

Press the SEMICOLON key to save a situation.

7 From the Options menu, choose Save Situation.

Space Simulator displays the Save Situation dialog box.

8 In the File Name box, type a name for your Mars Base situation (for example, type **mymars**).

9 In the Description box, type a description (for example, type **Launch from Mars**), and then choose the OK button.

You just created a situation so that you can start your flight plan from an outpost on Mars. You can also use any existing situation as the starting point for a flight plan.

Now you'll incorporate this situation into a complete flight plan. You'll launch the ATL from the surface of Mars, make an excursion to its nearby moons, and then fly back to the planet.

To use the MYMARS situation in your flight plan

1 From the Flight menu, choose Flight Computer.

Space Simulator displays the Flight Computer dialog box.

2 Choose the Use Flight Plan Situation check box.

When you choose this check box, the flight computer automatically begins with a specified situation.

3 Choose the Select Situation button.

Space Simulator displays the Select Flight Plan Situation dialog box.

4 From the list, choose MYMARS, and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays the current flight plan situation as MYMARS.

Now keep the Flight Computer dialog box open and create a step-by-step flight plan—it automatically begins at Mars Base Marineris.

To continue your flight plan from the MYMARS situation

1 In the Flight Computer dialog box, choose the Edit button to start specifying instructions.

Space Simulator displays the Instruction #1 dialog box so you can specify the first instruction for your flight plan.

2 Under Action, choose Launch, and then choose the Orbital Radius button to set the height for your orbit.

Space Simulator displays the Orbital Radius dialog box.

3 In the Altitude box, type **3000** (don't forget to choose Kilometers as the unit of measure—this figure refers to altitude above the surface), and then choose the OK button.

Space Simulator returns you to the Instruction #1 dialog box and displays 3000 kilometers as the orbital altitude.

If you need a definition or an explanation of a term, check the Glossary on page 198.

4 Under Launch Azimuth, type **270**.

The initial launch azimuth is 90 degrees because this angle positions your spacecraft for an equatorial orbit (in the direction of the Earth's rotation). You can change the launch azimuth to any number you want. For example, a 0-degree launch azimuth positions your spacecraft for a polar orbit (in the direction of the North Pole).

5 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Launch as the first instruction in your flight plan.

6 In the Instruction box, choose line 2, and then choose the Edit button.

Space Simulator displays the Instruction #2 dialog box.

7 Under Action, choose Rendezvous, and then choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

8 Under Object Type, choose Moons, choose Phobos from the list (note that Phobos is one of Mars's two moons and orbits Mars at a distance of about 6000 kilometers), and then choose the OK button.

Space Simulator returns you to the Instruction #2 dialog box and displays Phobos as your current destination.

9 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Rendezvous as the second instruction in your flight plan.

10 In the Instruction box, choose line 3, and then choose the Edit button.

Space Simulator displays the Instruction #3 dialog box.

11 Under Action, choose Coast, and then choose the Duration button.

Space Simulator displays the Event Duration dialog box.

12 In the Duration box, type **4.5** (don't forget to choose Minutes as the unit of measure), and then choose the OK button.

Space Simulator returns you to the Instruction #3 dialog box and displays 4.5 minutes as the duration of the coasting period.

So far, your flight plan includes launching from the surface of Mars, rendezvousing with its moon Phobos, and coasting next to it for 4.5 minutes.

13 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Coast as the third instruction in your flight plan.

14 In the Instruction box, choose line 4, and then choose the Edit button.

Space Simulator displays the Instruction #4 dialog box.

15 Under Action, choose Rendezvous, and then choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

16 Under Object Type, choose Moons, choose Deimos from the list (note that Deimos is Mars's outermost moon), and then choose the OK button.

Space Simulator returns you to the Instruction #4 dialog box and displays Deimos as your current destination.

17 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Rendezvous as the fourth instruction in your flight plan.

18 In the Instruction box, choose line 5, and then choose the Edit button.

Space Simulator displays the Instruction #5 dialog box.

19 Under Action, choose Land, and then choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

20 Under Object Type, choose Planets, choose Mars from the list, and then choose the OK button.

Space Simulator returns you to the Instruction #5 dialog box and displays Mars as your current destination.

21 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays your five-step flight plan.

22 Choose the Save button to save your new flight plan.

Space Simulator displays the Save Flight Plan dialog box.

23 In the File Name box, type a name for your flight plan (for example, type **mars1**).

24 In the Description box, type a description for your flight plan (for example, type **Round-trip from Mars Base Marineris to Phobos and Deimos**), and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box.

Z *Press to turn the autopilot on or off.*

25 Choose the Execute button to execute your flight plan (or choose the Close button if you want to store this flight plan and execute it later).

Sit back and let the flight computer take you on a round-trip journey from Mars to its two moons and back. To turn off the autopilot and manually control the instruments, press Z or click the autopilot display on the instrument panel.

Altering Your Orbit with Prograde and Retrograde

The Prograde and Retrograde actions are essential and basic tools for adjusting orbital flight. For a more detailed look at orbital mechanics, see "Advanced Space Piloting" on page 161.

Two important ingredients of piloting a spacecraft are prograde and retrograde actions. Prograde means to fly in the direction of an object or in the direction of an established orbit. Retrograde means to fly away from an object or in the opposite direction of an established orbit. Try perfecting your star-piloting skills by creating a flight plan that establishes an orbit around a planet in a distant solar system, and then alters it with prograde and retrograde.

To arrange your views for monitoring orbital alterations

1. From the Window menu, choose Hide View 1.

   Space Simulator hides View 1 and displays only the menu bar and instrument panel.

Prograde and retrograde adjustments are at the heart of orbital mechanics. However, you can also make prograde and retrograde adjustments while traveling in a straight line. For example, while making interplanetary or interstellar passages, you can choose a retrograde orientation so that your spacecraft is facing away from the destination object.

2. From the Window menu, choose Show Map View.

   Space Simulator displays Map View with our Sun at the center.

3. From the Window menu, choose View Controls.

   Space Simulator displays the View Controls dialog box.

4. Under View Controls For Window, choose Map View.

   Space Simulator displays the View Controls For Map View dialog box.

5. Under Map Origin, choose the Map Origin button.

   Space Simulator displays the Select Map Origin Object dialog box.

6. Under Object Type, choose Stars, choose Altair from the list, and then choose the OK button.

   Space Simulator returns you to the View Controls For Map View dialog box and displays Altair as your map origin. This means that Altair is always at the center of your Map View.

7. Under Show On Map, turn on Stars, Planets, and Spacecraft, and then choose the OK button.

   An X in a check box means the option is turned on. A blank check box means it is turned off. Make sure all objects are turned off except Stars, Planets, and Spacecraft.

You've now set the scene to monitor orbital alterations as your spacecraft carries out its flight plan. For the time being, all you can see is the star Altair, but soon Map View will include the planets of Altair's solar system and the Galactic Explorer as it alters its orbit.

To create a flight plan for altering your orientation with prograde

1. From the Location menu, choose Stars.

   Space Simulator displays the Stars dialog box.

2 From the list, choose Altair, and then choose the OK button.

Space Simulator places your spacecraft in an orbit about 6.8 million kilometers from the star Altair.

3 Press the MINUS SIGN key or click the Minus button on the view tools to increase the map scale so you can see Altair, Altair 1, and the Galactic Explorer.

A scale of about 30 astronomical units (AU) is good. You'll also see the other planets of Altair.

4 On the view tools, choose the View button to cycle to the view you want.

The View button in Map View always displays the name of the current view. Choose the button once and you cycle from Top to Front view. Choose it again and you cycle to Side view. Choose it once more and you return to Top view.

5 From the Flight menu, choose Flight Computer.

Space Simulator displays the Flight Computer dialog box.

6 Choose the Edit button to start specifying instructions.

Space Simulator displays the Instruction 1 dialog box so you can specify a first instruction for your flight plan.

7 Under Action, choose Orbit, and then choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

Space Simulator provides planetary systems around all its stars. In reality, it isn't known whether these stars actually have planets. Recent astronomical findings, however, show signs of planets around at least one star in addition to our Sun.

8 Under Object Type, choose Planets (note that these are now the planets of Altair's solar system), choose Altair1 from the list, and then choose the OK button.

Space Simulator returns you to the Instruction #1 dialog box and displays Altair1 as your current destination.

9 Choose the Orbital Radius button.

Space Simulator displays the Orbital Radius dialog box.

10 Choose Distance From Center and, in the Distance box, type **4** (make sure you choose Radii), and then choose the OK button.

Space Simulator returns you to the Instruction #1 dialog box with 4 radii as your orbital radius.

11 In the Orbital Inclination box, type **10**.

Orbital inclination refers to variation from the equatorial plane. An orbital inclination of 10 degrees means that the orbital plane intersects the equatorial plane at an angle of 10 degrees. A perfect equatorial orbit has an inclination of 0 degrees. A perfect polar orbit has an inclination of 90 degrees.

12 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Orbit as the first instruction in your flight plan.

13 In the Instruction box, choose line 2, and then choose the Edit button.

Space Simulator displays the Instruction #2 dialog box.

You'll first establish an orbit around the star Altair, and then enter into an orbit with the first planet in Altair's solar system, Altair1.

14 Under Action, choose Coast, and then choose the Duration button.

Space Simulator displays the Event Duration dialog box.

15 In the Duration box, type **2** (make sure you choose Minutes), and then choose the OK button.

Space Simulator returns you to the Instruction #2 dialog box and displays 2 minutes as the event duration.

16 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Coast as the second instruction.

17 In the Instruction box, choose line 3, and then choose the Edit button.

Space Simulator displays the Instruction #3 dialog box.

18 Under Action, choose Prograde, and then choose the Destination button.

Space Simulator displays the Select Destination Object dialog box.

19 Under Object Type, choose Planets, choose Altair1 from the list, and then choose the OK button.

Space Simulator returns you to the Instruction #3 dialog box and displays Altair1 as your current destination—or the planet around which you'll establish a prograde orientation.

20 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Prograde as the third instruction (referring to a prograde orientation in your orbit of Altair1).

21 In the Instruction box, choose line 4, and then choose the Edit button.

Space Simulator displays the Instruction #4 dialog box.

22 Under Action, choose Thrust, and then choose the Duration button.

Space Simulator displays the Event Duration dialog box.

23 In the Duration box, type **3** (make sure you choose Minutes), and then choose the OK button.

Space Simulator returns you to the Instruction #4 dialog box and displays 3 minutes as the event duration.

24 Choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Thrust as the fourth and final instruction.

25 Choose the Save button to create a new flight plan.

Space Simulator displays the Save Flight Plan dialog box.

26 In the File Name box, type a name for your flight plan (for example, type **prograde**).

27 In the Description box, type a description for your flight plan (for example, type **Orbiting Altair's first planet with prograde**), and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box.

Z *Press to turn the autopilot on or off.*

28 Choose the Execute button to execute your flight plan (or choose the Close button if you want to store this flight plan and execute it later).

In Map View, watch your spacecraft leave its orbit of Altair and establish an orbit around Altair1 with prograde. To turn off the autopilot and manually control the instruments, press Z or click the autopilot display on the instrument panel.

Since you only need to make minor changes to flight plan PROGRADE to establish a retrograde orientation, keep your window arrangement exactly the same and you'll soon be watching your spacecraft fly in the opposite direction.

To change flight plan PROGRADE to flight plan RETRO (retrograde)

1 From the Flight menu, choose Flight Computer.

Space Simulator displays the Flight Computer dialog box.

2 Choose the Open button to open an already existing flight plan.

Space Simulator displays the Open Flight Plan dialog box.

3 Under File Name, choose PROGRADE from the list, and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box.

4 In the Instruction box, choose line 3 (the Prograde instruction), and then choose the Edit button.

Space Simulator displays the Instruction #3 dialog box.

5 Under Action, choose Retrograde, and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box and displays Retrograde as the fourth instruction (referring to a retrograde orientation in your orbit around Altair1).

6 Choose the Save button to save this flight plan under a new name.

Space Simulator displays the Save Flight Plan dialog box.

7 In the File Name box, type a name for your flight plan (for example, type **retro**).

8 In the Description box, type a description for your flight plan (for example, type **Orbiting Altair's first planet with retrograde**), and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box so you can execute your new flight plan.

9 Choose the Execute button to execute your flight plan (or choose the Close button if you want to store this flight plan and execute it later).

Press F1 or click the up arrow on the time scale to increase the time so you can see your spacecraft in orbital motion around Altair1.

In Map View, watch your spacecraft leave its orbit of Altair and enter into an orbit around Altair1 with retrograde. To turn off the autopilot and manually control the instruments, press Z or click the autopilot display on the instrument panel.

You can automate any journey to the stars with the autopilot and flight computer. For a preview of the many possible destinations, visit Space Simulator's observatory in the next chapter.

Chapter 12
At the Observatory

"There has been for a very long time in my life a real sense of joy just to be able to look up into the heavens and to watch the stars move across the sky."—The Rev. Kenneth Beckmann (from New Horizons in Amateur Astronomy)

In this chapter you'll learn how to

- Use the observatory instrument panel.
- Change your observatory location.
- Choose what you want to look at through the telescope.
- Observe the sky in the present, past, or future.
- Understand what the heavens offer.

For a complete and convenient guide to all the keys you'll need at the observatory, choose Keyboard Guide from the Help menu, and then choose the Observatory Keys button.

Welcome to Space Simulator's observatory, where you can see galaxies, nebulas, and star clusters from your telescope before you start your space travel. The observatory is a perfect place to plan adventures and launch extraordinary expeditions.

With the Observatory command, you can view the heavens from some of the most renowned observatory sites on this planet or you can choose from a list of locations throughout the solar system. For absolute precision, you can set the exact latitude and longitude so that you look at the sky above your own backyard. You can even go one step further and set your view from the surface of a moon or planet—or go backward or forward in time and view past or future heavens. And because all great observatories are centers of learning, you can also brush up on your knowledge of the awesome structures that make up our galaxy and the huge realm of space beyond.

Using the Observatory Instrument Panel

Note that when you are at the observatory, not all the menus or commands are available. For example, the entire Flight menu is unavailable, as are nearly all commands on the Location menu. These commands are available again when you choose Free Flight from the Options menu and return to normal spaceflight.

Just like the great observatories of the real world, the Space Simulator observatory provides an instrument panel to help you find what you want to see. Similar to the instrument panel used during spaceflight, the observatory instrument panel provides you with a quick and clear means of exploration. The big difference is that at the observatory, you leave your spacecraft at home and explore through a telescope.

To go to the observatory

▶ From the Options menu, choose Observatory.

Space Simulator displays the observatory instrument panel. Notice that the view tools and the instrument panel are different from those used in spaceflight.

Picking a Place to Gaze at the Stars

Before you start viewing the stars, let's choose a viewing location. In Space Simulator, you can place your "telescope" at a number of surface locations such as observatories, cities, or even outer space.

Choosing a Surface Location

In Space Simulator, you can view the stars from several renowned observatories. In choosing one observatory over another, you don't actually see a difference in the viewing power or instrumentation, but you do enjoy a change in geographical location. For example, you can view the heavens of the southern hemisphere from Cerro Tololo or get an excellent view of the northern hemisphere from Mount Palomar.

You can also choose from several major cities around the world for your observatory location. See how the stars look over Paris tonight, or view the Moon from Moscow. If you want to see the skies over your own backyard, and don't know your exact latitude and longitude, you can choose the city nearest you for your viewing location.

Set a surface location on Mars, and see what the Earth looks like to Martians . . . or to future space colonists.

Finally, you can do something that real-life astronomers would just love to do—set your observatory location on the dark side of the Moon, or on a number of other extraterrestrial locations, such as Mars.

To choose your observatory location

1 From the Options menu, choose Observatory.

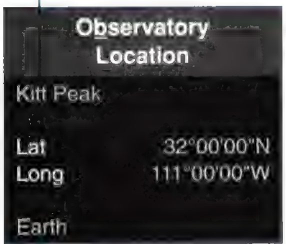
Space Simulator displays the observatory instrument panel.

You can also choose either Planets or Moons from the Location menu if you want to set a viewing location on another planet or moon.

2 From the Location menu, choose Surface.

Space Simulator displays the Surface Locations dialog box.

Press ALT+B, or click the observatory location display to change your observatory location.



The planet or moon where your telescope is located

Press ALT+B, or click the observatory location display to set exact latitude and longitude.

You can use the Set Location command to enter the coordinates for your own backyard. A library, municipal engineering department, or a detailed map can help you determine your latitude and longitude so you can see the stars and planets on the screen, just as they appear in the night sky above.

3 From the list, choose an observatory, city, or some faraway site where only Space Simulator telescopes are located.

   In the Description box, Space Simulator displays information about each site.

4 Choose the OK button.

   The observatory location display on the instrument panel shows the new location, including its latitude and longitude.

Setting Your Exact Location

You can also set an exact location—whether you know the coordinates or not. For example, you can look up the latitude and longitude of Ayers Rock, Australia, in the world atlas and set the observatory telescope to view from this vantage point. Or pick a location and Space Simulator displays the correct coordinates for you.

To set an exact viewing location

1 From the Options menu, choose Observatory.

   Space Simulator displays the observatory instrument panel.

2 From the Location menu, choose Set Location (you can also press ALT+B or click the observatory location display).

   Space Simulator displays the Set Observatory Location dialog box.

3 Choose the Planets button, the Moons button, or the Surface button for a list of possible observatory sites.

   Space Simulator displays the Planets, Moons, or Surface Locations dialog box.

4 From the list, choose the planet, moon, or surface location that you want for your viewing location, and then choose the OK button.

   Space Simulator returns you to the Set Observatory Location dialog box with the new viewing location and the correct latitude and longitude for that location.

5 If you know the latitude and longitude you want, you can type the exact coordinates in the Latitude and Longitude boxes, and then choose the correct hemisphere (North/South, East/West).

6 Choose the OK button.

   The observatory location display on the instrument panel shows the new location, including its latitude and longitude.

Now that you know how to choose an observation site, it's time to choose your target object and learn how to view it through the telescope.

Choosing Your Target Object and Using the Telescope

If you need a definition or an explanation of a term, check the Glossary on page 198.

There are three ways to focus in on a target object:

- Use the target display on the instrument panel.
- Enter exact right ascension (RA) and declination (Dec) or altitude (Alt) and azimuth (Azi) coordinates.
- Slew with your telescope.

First we'll describe the difference between panning and tracking when you are using the Space Simulator telescope, and then we'll launch into a discussion of the different methods for locating target objects.

Shifting Between Panning and Tracking

When you first visit the Space Simulator observatory, the Direction button on the view tools is set on Panning, which means that you can take a leisurely look at the sky around you.

If you want to focus in on a specific target object, all you need to do is choose the target object you want (by pressing the T key and picking one from the list) and Space Simulator automatically changes the Direction button to Tracking. Your target object is now at the very center of the screen, just waiting for you to adjust the zoom magnification.

Shifting between tracking and panning provides you with flexibility. Tracking mode is good for keeping your telescope locked onto your target object. Panning mode is nice for moving your view away from the target object to see what kind of neighbors it has.

To switch between Panning and Tracking modes

D *Press to switch between Panning and Tracking modes.*

▶ Press the D key or click the Direction button on the view tools to switch from Panning to Tracking mode.

The Direction button always displays the name of the current mode. Choose the button once and you switch from Panning to Tracking mode. Choose it again and you switch back to Panning mode.

Using the Target Display

When you use the target display, you have the wonders of the heavens at your fingertips. You can choose the type of object you want to look at—for example, a comet—and Space Simulator offers a list of all the available comets. Each time you choose a comet, Space Simulator displays a description of it.

You can also select a target object by choosing View Controls from the Window menu, and then choosing the Target Object button.

Here's a step-by-step guide to choosing a target object (in this case, a comet) as your viewing target.

To choose a target object

Press the T key, or click the target display to change your current target object.

Distance to the core of the target object

1. From the Options menu, choose Observatory.

   Space Simulator displays the observatory instrument panel.

2. Press the T key or click the target display on the instrument panel (you can also press ALT+R).

   Space Simulator displays the Select Target Object dialog box.

3. Under Object Type, choose the type of object you want to view.

   For example, choose Moons, and Space Simulator displays a list of available moons with a description below.

4. From the list, choose the specific object you want to view.

   For example, choose Earth's Moon to view the Moon.

5. Choose the OK button.

   Space Simulator displays the target object on the target display. Notice that the Direction button is now set to Tracking and you see a telescopic view of the object in the center of your screen. Use the Zoom buttons on the view tools to adjust your magnification (about 100X is good). Use the horizontal and vertical panning bars to adjust your view.

For more information on zooming and panning, see "Enjoying the Views with the View Tools" on page 6.

Entering Exact Coordinates

A second way of choosing a target object is to enter the exact right ascension (RA) and declination (Dec) or the exact altitude (Alt) and azimuth (Azi) coordinates. In this way, you can point the observatory telescope at a precise location in the sky.

Right ascension and declination and altitude and azimuth are the space equivalent of Earth's latitude and longitude and are used to measure the celestial sphere. For more information, see the illustrations on pages 140 and 141.

To enter exact coordinates

1. From the Options menu, choose Observatory.

   Space Simulator displays the observatory instrument panel.

2. Press ALT+V or click the view display on the instrument panel.

   Space Simulator displays the View Settings dialog box.

3. Next to Mode, choose either RA/Dec or Altitude/Azimuth.

   Space Simulator modifies the dialog box, depending on your choice.

4. In the Right Ascension and Declination boxes or in the Altitude and Azimuth boxes, type the exact coordinates for your target object.

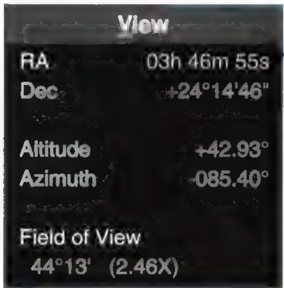
5. In the Field Of View box, type the viewing magnification you want.

   Type a higher number for a wider field of view and less magnification, or a lower number for a narrower field of view and more magnification. You can also change your field of view by zooming in and out. For more information, see "Zooming" on page 7.

6. Choose the OK button.

   Space Simulator displays the new RA and Dec or Altitude and Azimuth coordinates on the view display and the new target object on the target display. You'll see a telescopic view of the object in the center of your screen. Use the Zoom buttons on the view tools to adjust your magnification. Use the horizontal and vertical panning bars to adjust your view.

Press ALT+V, or click the view display to change RA/Dec or Alt/Azi coordinates.



Press ALT+V, or click the view display to change the field of view. You can also press the PLUS SIGN or MINUS SIGN key, or click the Zoom buttons to change the field of view.

Telescopic Slewing

Slewing is the term for turning a telescope about its base. It has nothing to do with the Slew Control command that you turn on to make flying in space easier. Amateur astronomers can tell you that it is a lot of fun to slew a telescope around and randomly search the skies for beautiful fields of stars.

At the Space Simulator observatory, you can slew your telescope with the keyboard, mouse, or joystick. For more information on slewing your telescope with a mouse or joystick, see "Using the Mouse" or "Using a Joystick" on pages 190 or 192.

Before slewing the telescope, press D to switch from Tracking to Panning mode. In Tracking mode, your tracking object is always in the center of the screen, so slewing has no effect.

To slew the telescope

1. From the Options menu, choose Observatory.

   Space Simulator displays the observatory instrument panel.

2. Press ALT+N or click the control readout on the observatory instrument panel to cycle to the slew setting you want.

   Make sure that your telescope is set to right ascension/declination (RA/Dec) or altitude/azimuth (Alt/Azi). Note that when you see Panning on the control readout, you aren't looking through your telescope—you are scanning the skies with your eyes, but you retain the current zoom magnification.

3. Press the UP ARROW key or DOWN ARROW key to adjust the height of your telescopic view.
   –or–
   Press the LEFT ARROW key or RIGHT ARROW key to adjust the horizontal aim of your telescope.
   –or–
   Press KEYPAD SLASH (/) or KEYPAD ASTERISK (*) to roll your view.

   The rotation gauge on the right side of the observatory instrument panel provides you with a visual reference for the direction and rate of your slewing.

The rotation gauge indicates the direction in which you are slewing your telescope. Press the arrow keys, or move the mouse or joystick to slew your telescope in the direction you want.

Press ALT+N, or click the control readout to cycle to RA/Dec, Alt/Azi, or Panning.

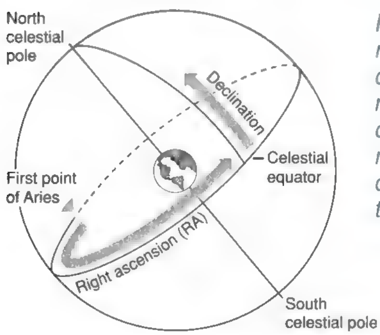
Before you try out the slew settings (RA/Dec or Alt/Azi), let's examine the methods astronomers have devised for measuring the heavens. From the earliest days of humanity, there has been a desire to measure the sky, driven by a fervent desire to understand it. What began as the search for a ram, or a chariot drawn by stars, evolved quite early into the precise system still used today.

First we'll look at the basics of latitude and longitude, and then at the two most common methods of gauging telescope movement—by measuring right ascension and declination or altitude and azimuth.

Latitude measurements are based on a series of imaginary circles that run parallel to the equator. Longitude measurements are based on a series of imaginary circles that run through the North and South Poles.

Latitude A good way to understand celestial measurements is to begin with earthly measurements. Latitude and longitude represent a simple yet elegant system of measurement that allows one to specify an exact location anywhere upon the surface of the Earth. Latitude is based upon a series of imaginary circles that wrap the globe parallel to the equator. The equator has a measurement of zero degrees, the North Pole has a measurement of plus 90 degrees, and the South Pole has a measurement of minus 90 degrees. The degrees are further broken down into minutes and seconds. New York City, for example, has a latitude of 40 degrees, 43 minutes, and 00 seconds North. Sydney, Australia, has a latitude of 33 degrees, 52 minutes, and 00 seconds South.

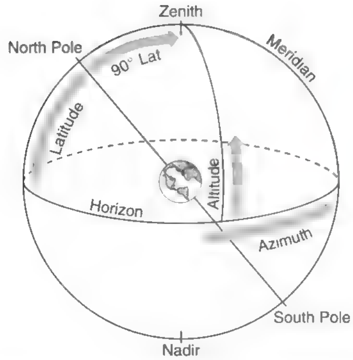
Longitude Lines of longitude run perpendicular to the lines of latitude. Whereas latitude is based upon reference points of the equator and the two poles, longitude is based upon imaginary lines drawn through the North and South Poles. The line of longitude passing through the old observatory in Greenwich, England is known as the Greenwich meridian. Longitude can be expressed either in degrees, minutes, and seconds, or in hours, minutes, and seconds. This is based upon the 360-degree circumference of the Earth turning every 24 hours. The Greenwich meridian also serves as the measuring base for Universal time.



In astronomy, longitude is expressed as right ascension (RA), which basically determines a telescope's side-to-side movement, although that movement is on an angle to match the Earth's rotational axis. Latitude is expressed as declination (Dec), which determines the telescope's up and down movement.

Right Ascension (RA) Right ascension is a celestial equivalent to longitude. As with longitude, it can be measured in either hours, minutes, and seconds, or in degrees, minutes, and seconds. Just as longitude has a zero point at Greenwich, England, right ascension has a zero point measured from the first point of Aries, which marks the position of the Sun as it crosses the celestial equator during the spring (or vernal) equinox.

Declination Declination is the celestial equivalent to latitude. It is measured in degrees north or south of the celestial (rather than the Earth's) equator. Declination is measured to plus 90 degrees of the north celestial pole, and to minus 90 degrees of the south celestial pole.



When pointing a telescope to a location expressed in altitude and azimuth (often shortened to alt-azi), altitude refers to the up and down movement, and azimuth refers to the side-to-side movement of the telescope.

Altitude Altitude is a measurement in degrees of an object's distance above the horizon. It is similar to declination. A 90-degree altitude points at the zenith.

Azimuth Azimuth is a measurement made horizontal to the horizon with respect to local North. A 0-degree azimuth points north, a 90-degree azimuth points east, a 180-degree azimuth points south, and a 270-degree azimuth points west.

The location for any celestial object can be given in either right ascension and declination, or in terms of altitude and azimuth.

Using Clock Drive and Tracking

Sidereal time is the term used to describe the 23 hours and 56 minutes it takes the Earth to spin around once on its axis.

The Space Simulator observatory offers three ways of controlling your telescope's movement. You can turn the clock drive on, turn the clock drive off, or you can switch to Tracking mode.

Using Clock Drive

If you want your telescope to move at a rate that offsets the 23-hour, 56-minute rotation of the Earth, turn your telescope clock drive on. The clock drive rotates your telescope in the opposite direction of the Earth's rotation, which lets you keep celestial objects in view. In real life, whether your telescope is out in your backyard or you are looking through a huge one at an observatory, a clock drive is used to compensate for the spinning of the Earth.

If you want your telescope to remain stationary as the sky "drifts by," turn your telescope clock drive off. Of course, the stars aren't really drifting; the planet is turning, but a stationary telescope can provide a pleasant effect.

To turn the clock drive on or off

- Press ALT+K or click the clock drive on the instrument panel.

Press ALT+K, or click here to turn the clock drive on or off.

Using Tracking Mode

For more information on switching to Tracking mode, see the procedure "To switch between Panning and Tracking modes" on page 136.

If you want to lock your telescope sights onto an object that is moving faster than the clock drive, switch the Direction button on the view tools to Tracking mode. For example, you can switch to Tracking mode to follow the movements of a satellite or an exceptionally fast comet.

Changing Observatory Time

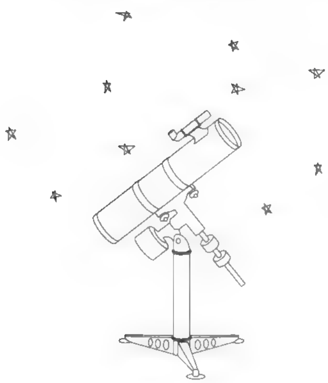
At the observatory, you can have fun playing with both time and date settings or you can use the time scale as a time machine.

Set the date for your birthday, a holiday, or a historical event and see what was happening in the skies above.

You can set the date on the time display for any point in time up to five million years into the future or back to 999,999 BC. This way, you can see what the stars and planets were doing on the day of your birth. Or fans of movie director Stanley Kubrick and science-fiction author Arthur C. Clarke can set the date for 2001 and observe the Moon, or set the date for 2010 and watch Jupiter.

You can adjust the time and date using the time display and time scale on the instrument panel, just as you do when you're flying your spacecraft. For more information, see "Playing with Time" on page 34.

Enjoying the Jewels of the Universe



Being inside an observatory is like wandering through a vault filled with priceless treasures. At Space Simulator's observatory, you can see some of the most beautiful galaxies, nebulas, and star clusters in all the heavens. Viewing these objects through a telescope gives you the chance to discover the mysteries and wonders of the sky. The more you know about such deep sky objects, the more fascinating they become. Here's a preview of what you can see.

The Great Nebula in Orion is one of the finest jewels in the sky. It is a vast cloud of hydrogen that glows with the light from hot young stars embedded within its folds. It is vast in size, stretching 30 light-years in diameter. Twenty thousand of our solar systems could easily be placed end to end within its boundaries. This nebula provides the glow of Orion's sword and it constitutes a stellar nursery where baby stars are burning with blue intensity as their ever-growing gravitational force draws more hydrogen from the cloud and into their bodies. Whereas our Sun is about five billion years old, the young stars of Orion are on the order of 10,000 and 20,000 years old. This makes them only infants, still nursing on their mother's hydrogen.

To see the Orion Nebula

1 From the Options menu, choose Observatory.

Space Simulator displays the observatory instrument panel.

T Press to change your target object.

2 Choose the target display on the instrument panel.

Space Simulator displays the Select Target Object dialog box.

3 Under Object Type, choose Deep Sky.

4 From the list, choose Orion Nebula.

In the Description box, Space Simulator displays a description of the Orion Nebula.

5 Choose the OK button.

To zoom in for a closer look at the Orion Nebula, press the PLUS SIGN key on the keyboard several times or click the Plus button on the view tools.

Space Simulator displays the Orion Nebula on the screen in front of you. Use the Zoom buttons on the view tools to adjust your magnification (about 100X is good). Notice that the target display on the instrument panel reads Orion Nebula.

Now that you know how to operate the telescope, you can view all the wondrous treasures of the galaxy. Use Space Simulator's observatory as your own planetarium and watch the constellations and planets pass above you at any time.

Chapter 13 Flying the Missions and Going on Galactic Adventures

"A cosmonaut, should he eat bread somewhere near Mars baked from wheat raised in a space laboratory, will, believe me, think of the grain and the flowers gathered on Earth!"—Dumitru Prunariu, Russian astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Experience a trip to the Moon with the Apollo 17 Mission.
- Practice landing at Cape Canaveral (and improving your score) with the Shuttle Mission.
- Race around the roads of Mars Base Marineris in the MMU.
- Pilot a freighter from one space station to another using the head-up display.
- Create a flight plan and then sit back and ride the orbits of the Galilean moons with Map View as your monitor.
- Explore new solar systems, photographing and videotaping their planets.
- Dive through the arching solar prominences of a star.
- Conduct a three-stage flight to the Moon.

Now it's time to take all you've learned and try out your skills on two missions that will score you on how precisely and gently you can dock and land your spacecraft. After experiencing the Apollo 17 Mission and the Shuttle Mission, you'll launch into deeper realms with a collection of galactic adventures you can fly on your own.

Flying the Apollo 17 Mission

It's been well over 20 years since humankind's last visit to the Moon. With the Apollo 17 Mission, you can relive this voyage. The flight plan is set. The flight computer automatically undocks the lunar excursion module (LEM) from the service module, and then you take over and descend for a lunar landing. Once on the surface, the flight computer launches you back into space, and again you take over and dock with the mothership for the trip home. Work carefully: Space Simulator scores you on how well you line up your landing, how gently you touch down, and how quickly you accomplish these tasks. You also get points for how precisely you dock with the mothership, the service module.

To Fly the Apollo 17 Mission

1. From the Options menu, choose Missions.

   Space Simulator displays the Missions dialog box.

2. From the list, choose Apollo 17 Mission, and then choose the OK button.

   Space Simulator displays a description of the Apollo 17 Mission.

3. Choose the Start Mission button after reading the description.

   Space Simulator transports you into lunar orbit, and the LEM undocks from the service module.

4. When Space Simulator displays the Apollo 17 Mission Landing Maneuver dialog box, choose the Begin Final Descent button.

   Space Simulator splits the screen and displays a chase craft view of the LEM on the left and a view from your cockpit on the right.

5. Press KEYPAD PLUS SIGN several times to apply thrust to slow your descent.

   Because your thrusters are facing toward the Moon's surface, applying thrust counteracts the Moon's gravitational pull. Be careful not to apply too much thrust or you'll accelerate away from the Moon.

6. Press PAGE UP and PAGE DOWN to align the LEM vertically, and press INSERT and DELETE to align horizontally with the landing spot.

   Once you are on the Moon's surface, Space Simulator displays your landing score and information on your distance from the target and your impact velocity.

7. Choose the Prepare For Launch button, and then choose the Launch To Orbit button when you are ready for the flight computer to launch the LEM back into space

   Press F1 to speed up the time scale if you want to get back to the service module in a hurry.

   Watch as the LEM separates from its descent stage and blasts away from the surface of the Moon.

8. When Space Simulator displays the Apollo 17 Mission Docking Maneuver dialog box, choose the Begin Docking button.

   Space Simulator displays a chase craft view of the service module on the left side of the screen and, on the right, you'll see a view from the LEM cockpit as you approach the docking port of the service module.

9. Yaw and pitch to orient the LEM, apply forward fine thrust to move toward the docking port of the service module, and then apply backward fine thrust to slow your closing speed as you approach.

   Upon docking, Space Simulator displays your total mission score, combining your landing and docking scores.

10 Choose the Exit Apollo 17 Mission button to return to normal spaceflight.

Now test your docking skills further with the Shuttle Mission that offers a grand finale landing at Cape Canaveral.

Docking the Shuttle Mission

When humanity begins to develop habitats in space, there will be a big demand for skillful pilots who can transport people and supplies safely between Earth and a network of space stations and surface colonies. The Shuttle Mission lets you see how well you've developed your docking and landing skills. The mission begins with the launching of your space shuttle into a rendezvous orbit with Space Station Freedom. From there it's up to you to dock your spacecraft as smoothly and as quickly as possible. The final part of the challenge is landing the shuttle.

To fly the Shuttle Mission

1 From the Options menu, choose Missions.

   Space Simulator displays the Missions dialog box.

2 From the list, choose Shuttle Mission, and then choose the OK button.

   Space Simulator displays a description of the Shuttle Mission.

3 Choose the Start Mission button after reading the description.

   Space Simulator begins the countdown, and then launches the shuttle into space. Enjoy the view as the flight computer carries the shuttle into a rendezvous orbit with Space Station Freedom.

Note that the flight from Cape Canaveral to the orbiting space station can take several minutes. Press F1 or click the up arrow on the time scale to increase the time and shorten your trip.

4 When Space Simulator displays the Shuttle Mission Docking Maneuver dialog box, choose the Begin Docking button.

   Space Simulator displays a chase craft view of the shuttle on the left side of the screen and, on the right, you'll see a view from the space shuttle's docking-port camera as you approach the docking port of Space Station Freedom.

5 Press PAGE UP on the keypad to apply fine thrust while you steer to line up with the docking port as you approach it.

   The right side of your screen provides a close-up view of the station's docking port.

6 Press PAGE DOWN on the keypad to slow your ascent toward the docking port.

   Just how much up thrust and down thrust to use is up to you. When you dock, Space Simulator displays the Shuttle Mission Docking Report. Your score is based on how well you line yourself up with the space station, how gently you dock, and how quickly you accomplish these tasks.

For more information on honing your landing skills, see "Landing at Cape Canaveral" on page 161.

7 Choose the Undock And Deorbit button to begin the second half of the Shuttle Mission, in which you'll land the shuttle at Cape Canaveral.

Space Simulator automatically undocks the shuttle from Space Station Freedom, coasts for a few seconds, turns to a retrograde orientation, and applies thrust to achieve a deorbit burn. Then Space Simulator displays the Shuttle Mission Landing Maneuver dialog box.

8 Choose the Begin Final Approach button when you are ready to land at Cape Canaveral.

Space Simulator places you within several kilometers of the landing strip. Because the Shuttle Landing Facility is your reference object, your distance and altitude are displayed on the instrument panel. The attitude display (as well as the head-up display, if you turn it on) shows yaw, pitch, and roll readings of zero when you are perfectly aligned with the landing strip.

G *Press to extend or retract landing gear.*

9 Steer the shuttle in for a landing at Cape Canaveral, and your mission is complete!

Upon landing, Space Simulator displays your total mission score, combining your docking and landing scores.

10 Choose the Exit Shuttle Mission button to return to normal spaceflight.

Now that you've flown the Space Simulator missions, you're ready to set out on your own galactic adventures. Bon voyage!

Mars Base Road Race

The Mars Base road race is an adventure much like a sports car race on Earth, but your vehicle is an MMU rather than an MG. The object is to cover the course from beginning to end as quickly as possible, without leaving the road. You'll be racing against the clock.

To compete in the Mars Base road race

1 From the Location menu, choose Surface.

Space Simulator displays the Surface Locations dialog box.

12:00:00 on August 31, 2020, is a good time and date for a clear view of Mars Base Marineris.

2 From the list, choose Mars Base Marineris, and then choose the OK button.

Space Simulator transports you to Mars Base Marineris. If you've changed the time and date during earlier spaceflights, and the Mars Base is hidden in darkness, just reset the time and date. For more information, see "Playing with Time" on page 34.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

3 On the view tools, choose the Location button and cycle to Chase view so you can watch your spacecraft and the base below as you fly.

4 From the Flight menu, choose Spacecraft.

Space Simulator displays the Spacecraft dialog box.

5 From the list, choose Manned Maneuvering Unit, and then choose the OK button.

Space Simulator suits you up in the MMU.

For more information on slewing, see "Slewing Through Space" on page 46.

6 Press the Y key to switch to slew control, and then apply downward thrust to lower the MMU onto Landing Pad 2 of Mars Base Marineris.

7 From the Options menu, choose Save Situation, or press the SEMICOLON (;) key to save your current situation so that if you want to begin over again, the scene is already set.

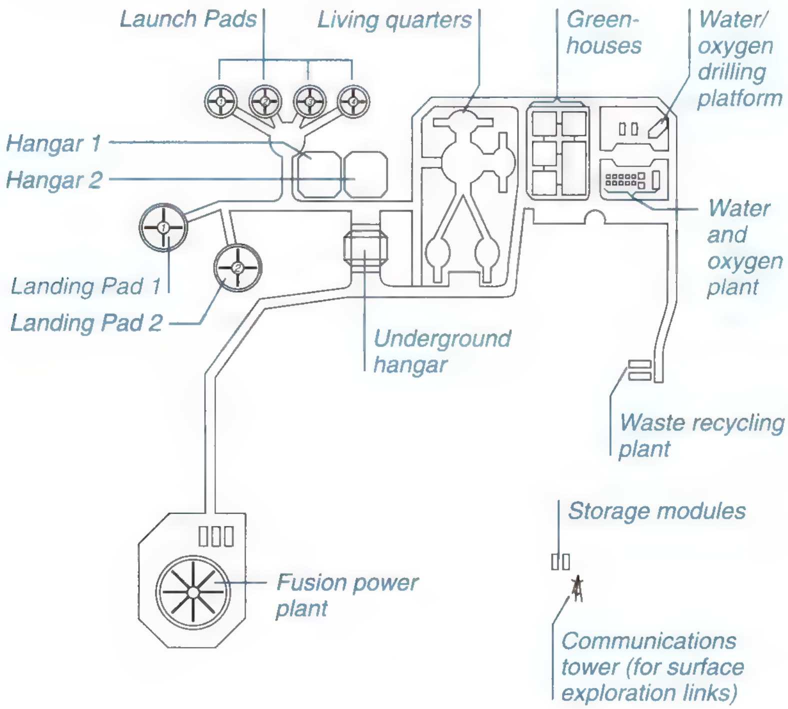
Space Simulator displays the Save Situation dialog box.

If you want a more challenging road race, try this adventure using the all terrain lander (ATL) in flight control rather than slew control. Remember to slow down around corners and use some upward thrust to counter gravity.

8 In the File Name box, type a name for your situation.

You can type up to eight letters for the name. Call it something that you'll remember easily, such as MARSRACE. It is a good idea to make incremental saves along the way by saving the situation again as you proceed on your adventure.

9 Refer to the map below and fly your MMU just a few meters above the Mars Base in a trial run around the course.



- From Landing Pad 2, head toward the living quarters, circling around them once.
- Continue on past the greenhouses to the water/oxygen drilling platform, and complete one full lap around it.
- Proceed to the waste recycling plant, and do another full circle.
- Dash to the finish line, which is marked by the communications tower.

Congratulations—you made it! Now try it again, and this time watch the time readout on the instrument panel, or clock the time on your wristwatch. See how quickly you can complete the course without leaving the road. Then move on—create your own routes and have fun exploring Mars Base Marineris.

The Zander Freighter Supply Ship Run

For hundreds of years, poets, novelists, and adventure-seekers on Earth have jumped aboard freighters, powered either by wind or engines, to escape the mundane and seek out foreign ports. In the following adventure, you can enjoy this spirit of exploration on a huge freighter that travels to space stations for its ports of call. So jump aboard the Zander Freighter, and captain it from one space station to the next, using the head-up display as your guide.

To fly the first leg of the Zander Freighter supply ship run

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.
2. Under File Name, choose FLIGHT, and then choose the OK button.

   Space Simulator places you in a familiar orbit around the Earth.
3. From the Flight Menu, choose Spacecraft.

   Space Simulator displays the Spacecraft dialog box.
4. From the list, choose Zander Freighter, and then choose the OK button.

   The sleek orange freighter is now at your command.
5. Press ALT+R or click the reference display on the instrument panel to change the reference object.

   Space Simulator displays the Select Reference Object dialog box.
6. Under Object Type, choose Space Stations.

   Space Simulator displays a list of space stations.

Don't forget to save your current situation often so that if you want to begin over again, the scene is already set. For more information, see the procedure "To save a new situation" on page 99.

7 From the list, choose Ring Station 1, and then choose the OK button.

Ring Station 1 is now your reference object. The distance readout displays the distance between your spacecraft and the space station—more than 30,000 kilometers.

H — Press to quickly turn the head-up display on or off.

8 From the Window menu, choose Show Head-Up Display.

Space Simulator superimposes the head-up display on your cockpit window. For information on how to keep the head-up display from rotating at the same rate as Ring Station 1, see page 188.

For more information on slewing, see "Slewing Through Space" on page 46.

9 Press the Y key to switch to slew control, and then take off for your first port of call, Ring Station 1.

Remember, if you keep the head-up display centered both horizontally and vertically, you'll automatically fly straight for your reference object (in this case, Ring Station 1).

10 Press F1 or click the up arrow on the time scale to increase the time so the distance won't seem quite as long (unless you are extremely patient and want to make the voyage in real time).

11 When you arrive at Ring Station 1, dock the Zander Freighter and give your crew a chance to see something beyond the inside of their own spacecraft.

For more information on docking, see "Docking and Walking in Space" on page 86.

Now that you've made it to one of the space stations, the rest of your run will be easy.

To fly to the rest of the ports of call

1 Press ALT+R or click the reference display on the instrument panel to change the reference object.

For more information on flying with the head-up display, see "Using the Head-Up Display" on page 69.

This time, make your reference object the Lunar Orbiter and watch the distance readout for the distance between your spacecraft and the lunar space station.

2 From the Flight menu, choose Undock, and accelerate toward the Moon.

Of course, you could use the flight computer and the autopilot to make this passage easy, but that wouldn't be nearly as much fun as doing the flying yourself using the head-up display. So speed up the time scale again, keep the head-up display centered, and enjoy this second leg of your voyage.

3 Upon reaching your destination, dock the Zander Freighter to the Lunar Orbiter.

While your crew is celebrating the arrival, take a break from the controls and relax with a drink and a snack.

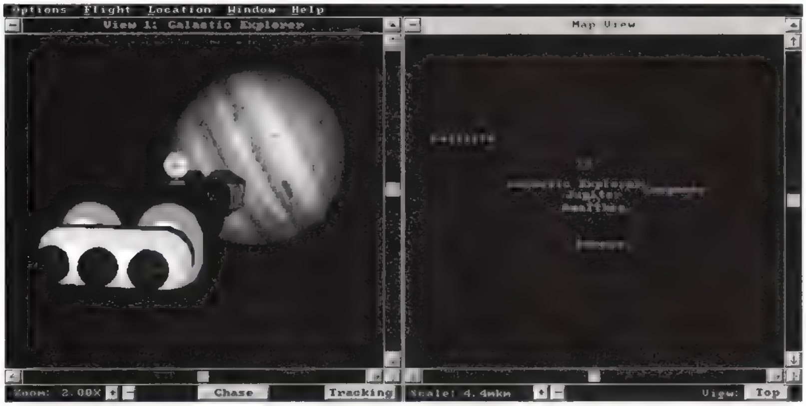
If you want more of a challenge, try this adventure using flight control instead of slew control.

Follow the above procedure to continue on to the third stop, the Mars Orbiter space station—quite a journey! If you enjoyed this supply ship run, design your own trade routes and set out for new destinations. There's a lot of space out there to explore.

Riding the Galilean Carousel

Jupiter has at least 17 moons, but is best known for Callisto, Ganymede, Europa, and Io, all discovered on January 7, 1610 by the great astronomer Galileo, and also called the Galilean moons. Riding the Galilean carousel provides a way of visiting these four famous moons, while getting an inside look at orbital mechanics as the moons circle Jupiter along their separate orbital paths. You'll use the flight computer to make it easy, starting with an orbit of Jupiter and then, as if shifting from one horse to another on a carousel, you'll hop to one Galilean moon after another, beginning with the nearest, Io, and working your way out to the most distant of the four, Callisto.

It can be fascinating to watch a flight plan unfold with the added perspective of Map View. Watch a close-up of your speeding spacecraft in View 1, while you get the big picture of your trajectory in Map View. A classic example of how to make the most of Map View in conjunction with the flight computer is to create a flight plan that starts with an orbit around Jupiter and then transfers your orbit to Jupiter's Galilean moons.



To arrange your views for monitoring an orbital change

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

1. On the view tools, choose the Location button and cycle to Chase view so you can watch your spacecraft as you fly in View 1.
2. From the Window menu, choose Show Map View.

   Space Simulator arranges your screen, displaying View 1 on the left and Map View on the right.

3 From the Window menu, choose View Controls.

Space Simulator displays the View Controls dialog box.

4 Under View Controls For Window, choose Map View.

Space Simulator displays the View Controls For Map View dialog box.

5 Under Map Origin, choose the Map Origin button.

Space Simulator displays the Select Map Origin Object dialog box.

6 Under Object Type, choose Planets, choose Jupiter from the list, and then choose the OK button.

Space Simulator returns you to the View Controls For Map View dialog box and displays Jupiter as the map origin. This means that Jupiter is always in the center of your Map View.

7 Under Show On Map, turn on Planets, Moons, and Spacecraft, and then choose the OK button.

An X in a check box means the option is turned on. A blank check box means it is turned off. Make sure you turn off Stars, Comets, Asteroids, and Space Stations.

M *Press to display Map View or make it active.*

8 Press the PLUS SIGN key or click the Plus button on the view tools to increase the magnification in Map View so that you can see the four Galilean moons—Io, Europa, Ganymede, and Callisto. You'll also see the tiny moon, Amalthea, which was discovered much later than the Galilean moons.

A zoom setting of 4.4 million kilometers (the vertical size of the map display) works well. Note that you can also see the moon, Amalthea, between Jupiter and Io. If the labels overlap, it's due to the proximity of the moons.

You're now set to use Map View to monitor orbital changes as your spacecraft carries out its flight plan. For the time being, all you can see is Jupiter and its moons, but soon Map View will include the Galactic Explorer on its rounds.

To ride the Galilean carousel to Io and monitor your orbital transfer in Map View

For more examples of changing orbits with the flight computer and watching the results in Map View, see "Advanced Space Piloting" on page 161.

1 From the Location menu, choose Planets, choose Jupiter from the list, and then choose the OK button.

Space Simulator places you in orbit around Jupiter. The reference display shows you are orbiting at a distance of 285,600 kilometers. You can now see a label for the Galactic Explorer in Map View.

When you are using the autopilot or flight computer, the rate of the time scale automatically changes depending on the distance to the destination.

2. Press F1 or click the up arrow on the time scale to increase the time so that you can see the Galilean moons and your spacecraft orbiting Jupiter.

   A rate of about 2.3 hours per second gives you a good view; however you can set the scale higher or lower according to your own liking.

3. From the Flight menu, choose Flight Computer.

   Space Simulator displays the Flight Computer dialog box.

4. Choose the Edit button to start specifying instructions.

   Space Simulator displays the Instruction #1 dialog box so that you can specify a first instruction for your flight plan.

5. Under Action, choose Rendezvous, and then choose the Destination button.

   Space Simulator displays the Select Destination Object dialog box.

6. Under Object Type, choose Moons, choose Io from the list, and then choose the OK button.

   Space Simulator returns you to the Instruction #1 dialog box and displays Io as your current destination.

7. Choose the OK button.

   Space Simulator returns you to the Flight Computer dialog box and displays Rendezvous as the first instruction in your flight plan.

8. In the Instruction box, choose line 2, and then choose the Edit button.

   Space Simulator displays the Instruction #2 dialog box.

9. Under Action, choose Coast, and then choose the Duration button.

   Space Simulator displays the Event Duration dialog box.

10. In the Duration box, type **4** (make sure you choose Minutes), and then choose the OK button.

    Space Simulator returns you to the Instruction #2 dialog box and displays 4 minutes as the event duration.

11. Choose the OK button.

    Space Simulator returns you to the Flight Computer dialog box and displays Coast as the second Instruction.

12 Choose the Save button to save your new flight plan.

Space Simulator displays the Save Flight Plan dialog box.

13 In the File Name box, type a name for your flight plan (for example, type **jupiter1**).

14 In the Description box, type a description for your flight plan (for example, type **Jupiter orbital transfer and rendezvous with Io**), and then choose the OK button.

Space Simulator returns you to the Flight Computer dialog box.

15 Choose the Execute button to execute your flight plan (or choose the Close button if you want to store this flight plan and execute it later).

In Map View, watch your spacecraft leave its orbit of Jupiter and rendezvous with Io. In View 1, watch your progress as you travel. To turn off the autopilot and manually control the instruments, press Z or click the autopilot display on the instrument panel.

For more information on arranging windows, see "Arranging Views" on page 14.

You can watch your spacecraft in Chase view in View 1 while watching your progress in Map View. If you want to dedicate your entire screen to Map View, just hide View 1, the instrument panel, and the view tools.

Once you are in orbit around Io, follow the same process for continuing on to Europa, Ganymede, and Callisto.

Photo Shoot for the Planets of Polaris Quarterly

In an effort to encourage more tourism to the Polaris solar system, the magazine, *Planets of Polaris Quarterly,* is sending you on a photo assignment that is out of this world. You'll use the Camera command on the Options menu to take space photographs of each of Polaris's nine planets, with a different spacecraft posed in front of each.

To take photos of the planets of Polaris

1 From the Location menu, choose Stars.

Space Simulator displays the Stars dialog box.

2 From the list, choose Polaris (noting the information in the Description box), and then choose the OK button.

Space Simulator transports you to an orbit around the star Polaris.

3 From the Location menu, choose Planets.

Space Simulator displays the Planets dialog box. Note that a new set of planets—the planets of Polaris (labeled Polaris I, Polaris II, and so on)—is now part of the list.

4 From the list, choose Polaris I, and then choose the OK button.

Space Simulator transports you into orbit around Polaris I, the first planet out from the star Polaris.

S — *Press to cycle through Cockpit, Chase, and Assigned views.*

5 On the view tools, choose the Location button and cycle to Chase view so that you can view your spacecraft against the backdrop of Polaris I.

B — *Press to quickly switch between relative and absolute chase craft perspectives.*

6 Change the chase craft perspective to absolute, and then press SHIFT+7 for a side view of your spacecraft. For more information on absolute versus relative perspective, see "Controlling Views" on page 16.

7 Apply a small amount of thrust and maneuver your spacecraft into position for a dramatic snapshot.

For more information on accelerating and steering your spacecraft, see "First Flight" on page 18.

8 Press ALT+PLUS SIGN to decrease the distance between the chase craft and your spacecraft and make your ship look larger against the planetary backdrop—or press ALT+MINUS SIGN to increase the distance between the chase craft and your spacecraft and make your spacecraft look smaller against the looming planet behind it.

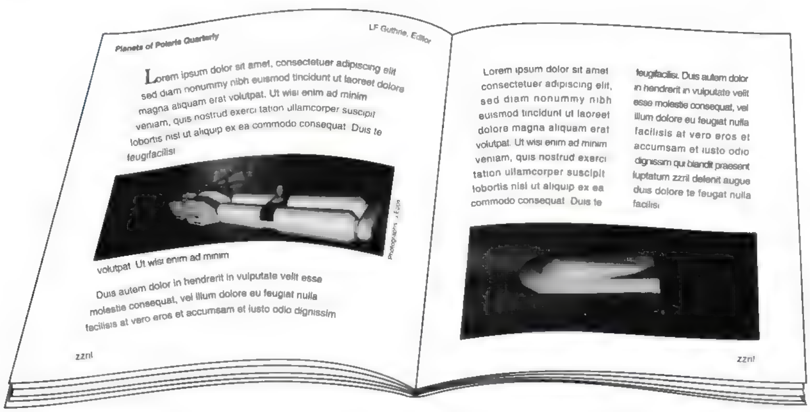
Print Scrn — *You can also press the PRINT SCREEN key to take a space photograph.*

9 When you've framed the perfect photograph, from the Options menu, choose Camera.

Space Simulator displays the Camera dialog box.

10 In the Image File Name box, type a name for your photo, and then choose the OK button.

You can type up to eight letters for the name. Call it something that you'll remember easily, such as POLARIS1 (and remember to give each subsequent photo a different name—for example, POLARIS2, POLARIS3, and so on).



Now that you've taken the first photo in the series, you can finish the assignment by shooting all of Space Simulator's spacecraft in front of each of Polaris's planets. Taking space photographs is a great way to chronicle your adventures in space. It's nice to know that whenever you see a spectacular image, you can capture it with the Camera command.

Videotaping the Vega Planetary Flybys

The Galactic News Network has hired you, and your assignment is to record video images of a newly discovered series of planets. So fasten your seat belt and turn on your video recorder. You'll be the first to film the planets of the Vega solar system as you fly by them.

Space Simulator provides planetary systems around all its stars. In reality, it isn't known whether these stars actually have planets. Recent astronomical findings, however, show signs of planets around at least one star in addition to our Sun.

Remember the following shortcut keys:

R *Press to start recording a video.*

U *Press to pause or resume a video recording.*

; \ *Press to stop recording or playing a video.*

P *Press to play a video.*

To videotape the Vega planetary flybys

1. From the Location menu, choose Stars.

   Space Simulator displays the Stars dialog box.

2. From the list, choose Vega (noting the information in the Description box), and then choose the OK button.

   Space Simulator places you in orbit about 14 million kilometers from Vega.

3. Crank up your speed and steer toward Vega.

   Your assignment is to proceed to the first of Vega's planets and videotape what you find there. If you want to go there quickly, you can choose Planets from the Location menu, and then choose Vega I (the first planet out from Vega). You can also use the autopilot and flight computer. Or if you want to fly to the planet using the head-up display, make sure to update your reference object to Vega I.

4. As you approach the planet, choose Video Recorder from the Options menu.

   Space Simulator displays the Video Recorder dialog box.

5. In the File Name box, type a name for your video.

   You can type up to eight letters for the name. Call it something that you'll remember easily, such as VEGA.

6. In the Description box, type any notes that you want.

7. Choose the Record button to begin recording immediately.
   –or–
   Press the Close button to return to Space Simulator and set up the shoot. Once the stage is set just the way you want it, press the R key to start recording.

8. Continue to explore the planets of Vega, and make a video recording of each planet that you visit.

Video recordings can take up a lot of space on your hard disk. To delete video files, choose Video Recorder from the Options menu, choose the filename you want to delete, and then choose the Delete button.

After your filming on Vega is complete, set off for another star's solar system and continue your pioneering work with the video recorder.

Diving Through the Solar Arches

This adventure is definitely not for the faint of heart! It takes you close to the star, Achernar, where you withstand unimaginable temperatures as you pilot your spacecraft beneath huge stellar flares that shoot like volcanic geysers from its surface. Get ready for the heat!

Make sure you fly this adventure at practice skill level—at the intermediate and advanced levels, you'll fry!

To dive through the solar arches

1. From the Location menu, choose Stars.

   Space Simulator displays the Stars dialog box.

2. From the list, choose Achernar (noting the information in the Description box), and then choose the OK button.

   Achernar is a hot blue giant that burns 650 times brighter than Earth's Sun. And it has a diameter of 13 million kilometers. The star is big, so proceed with caution.

For more information on slew control, see "Slewing Through Space" on page 46. For more information on accelerating and steering your spacecraft, see "First Flight" on page 18.

3. Press the Y key to switch to slew control and make your flying easier.

   The gravitational attraction of Achernar (as well as all other stars) is so great that only the foolhardy would try this adventure without the gravity protection offered by slew control.

4. Apply thrust until you reach a velocity that you feel comfortable with.

   For example, around 74,948 kilometers per second is a good way to make progress without getting there too fast.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

5. On the view tools, choose the Location button and cycle to Chase view so you can watch your spacecraft as it heads toward the star.

   If you would like to try a different spacecraft for this risky voyage, just choose Spacecraft from the Flight menu, and choose a new ship.

6. Steer your ship toward one of the great orange solar flares spewing hot arches that extend for thousands of kilometers.

The initial readout on the reference display shows distance. Radius and altitude information is not available until your spacecraft is within 99,999 kilometers (altitude) of the reference object.

7. When you get near enough, press ALT+S or click below the reference object on the instrument panel to change the reference display from distance to radius and altitude.

   The altitude readout shows how far your spacecraft is from the surface of the star, while the distance readout shows how far your spacecraft is from the core of the star.

8. As you draw nearer to the surface of the star, reduce your velocity to a few thousand kilometers per second so that you have the time to aim for one of the solar flares. As you get closer and closer, continue to reduce your speed.

9. Navigate your ship between the surface of the star and the solar flare above it and you'll pass through one of the hottest arches imaginable.

You survived the first run! Now, if you dare, circle back and fly your ship through another arching solar flare.

A Three-Stage Visit to the Moon

Part of the fun of Space Simulator is that you can switch from one spacecraft to another according to your exploration needs. In this adventure, you'll leave Earth orbit in the Galactic Explorer, fly to a lunar orbit and deploy the all terrain lander (ATL) to land on the surface of the Moon, and then venture out on a space walk in the manned maneuvering unit (MMU). Think of all the craters you can explore!

To fly from Earth to a lunar orbit—stage 1

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.
2. Under File Name, choose FLIGHT, and then choose the OK button.

   Space Simulator places you in the familiar Earth orbit, aboard the interstellar spacecraft, Galactic Explorer.
3. Press ALT+R or click the reference display on the instrument panel to change the reference object from Earth to the Earth's Moon.

   Space Simulator displays the Select Reference Object dialog box.
4. Under Object Type, choose Moons.

   Space Simulator displays a list of moons.
5. From the list, choose Earth's Moon, and then choose the OK button.

   The reference display on the instrument panel shows the distance between your spacecraft and the Moon.
6. On the view tools, check the Direction button to make sure you are in Panning mode.

   The head-up display doesn't work when the view direction is set for Tracking.
7. From the Window menu, choose Show Head-Up Display.

   Space Simulator superimposes the head-up display on your cockpit window.
8. Press the Y key to switch to slew control and make your journey easier.
9. Apply thrust, and begin your journey.

   With Slew Control, a velocity of anywhere from a few hundred kilometers per second to a few thousand kilometers per second works well. Just be careful about applying too much velocity—you don't want to fly past the Moon before you have a chance to react.

D — Press to switch between Panning and Tracking modes.

H — Press to quickly turn the head-up display on or off.

Press the PAUSE key whenever you want to stop for a moment to assess the situation. Press PAUSE again to resume spaceflight.

10 When the distance readout on the reference display shows less than 30,000 kilometers, press ALT+S or click below the reference object on the instrument panel to change the reference display from distance to radius and altitude.

The altitude readout shows how far your spacecraft is from the surface of the Moon.

If you get to within 4 radii of the Moon, and the lighting isn't good, press ALT+T or click the time display and set the date for 06 Feb 2001.

11 When you reach an altitude of 1000 kilometers above the surface, press HOME to cut all thrust and velocity and stop your movement toward the Moon.

Congratulations! You've completed the first stage of the journey by flying your spacecraft from Earth to a lunar orbit. Now continue on for a lunar landing.

To land on the Moon—stage 2

1 From the Flight menu, choose Deploy Lander.

The all terrain lander (ATL) descends from your spacecraft.

S *Press to cycle through Cockpit, Chase, and Assigned views.*

2 On the view tools, choose the Location button and cycle to Chase view so you can watch the ATL as it heads toward the surface of the Moon.

3 From the Options menu, choose Save Situation, or press the SEMICOLON (;) key to save your current situation so that if you want to begin over again, the scene is already set.

Space Simulator displays the Save Situation dialog box.

4 In the File Name box, type a name for your situation.

You can type up to eight letters for the name. Call it something that you'll remember easily, such as MOON1. It's a good idea to save frequently when you're involved in a complex adventure so that if something goes wrong, you don't lose the whole situation.

For more information on accelerating and steering your spacecraft, see "First Flight" on page 18.

5 Apply downward thrust and maneuver the ATL toward the lunar surface.

You might enjoy flying this leg of the mission under Flight Control rather than Slew Control so that you can see the effects of lunar gravity and use downward thrust to neutralize the gravitational pull of the Moon as you land. For more information on making a soft lunar landing, see "Landing on the Moon" on page 44.

6 Press the G key to lower the landing gear.

See if you can achieve a soft-touch landing with a velocity of less than 10 meters per second.

Bravo! Now that you've accomplished the perfect lunar landing and the ATL is firmly grounded on the surface of the Moon, it's time to begin the third stage of the journey—lunar exploration in the MMU.

To spacewalk on the Moon—stage 3

1. From the Flight menu, choose Space Walk.

   Space Simulator launches the MMU and you can begin wandering around the Moon.

Y *Press to turn slew control on or off.*

2. Press the Y key to switch to slew control (otherwise the Moon's gravity is too strong).
3. Apply thrust and fly your MMU at an elevation of just a few meters above the Moon's surface.

   Explore the geography of the Moon—observe its barren landscape. See if you can find any friendly mementos left by past visitors.
4. From the Flight menu, choose Reboard Craft.

   Your space walk is over and it's time to take over the controls of the ATL once again and fly back to the Galactic Explorer.
5. Press ALT+R or click the reference display on the instrument panel to change the reference object.

   Space Simulator displays the Select Reference Object dialog box.
6. Under Object Type, choose Spacecraft.

   Space Simulator displays a list of spacecraft.
7. From the list, choose Galactic Explorer, and then choose the OK button.

   The Galactic Explorer is now your reference object. The distance readout displays your distance from it.

H *Press to quickly turn the head-up display on or off.*

8. From the Window menu, choose Show Head-Up Display.

   Space Simulator superimposes the head-up display on your cockpit window. If you don't see the head-up display, check the view tools and make sure that you are in Cockpit view and Panning mode, and that your panning bars are centered.

For more information on flying with the head-up display, see "Using the Head-Up Display" on page 69.

9. Center the head-up display both horizontally and vertically, and fly straight for your reference object (in this case, the Galactic Explorer), coming as close to it as you can.
10. From the Flight menu, choose Retract Lander to return the ATL to its berth, and then sit back in the captain's chair and take over the controls of the Galactic Explorer.

This adventure is just one example of how you can use multiple spacecraft for a single adventure. With a whole galaxy waiting for you, you can give all of Space Simulator's spacecraft a good workout.

Chapter 14
Advanced Space Piloting

"We went to the moon as technicians; we returned as humanitarians."—Edgar Mitchell, American astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Enter the atmosphere and land at Cape Canaveral.
- Compute velocity and acceleration with equations.
- Execute flight plans without the flight computer.
- Adjust orbits with apogee kicks and retroburns.
- Appreciate Einstein's theory of relativity.

For more information about spaceflight and exploration, see "More Information About Space" on page 176.

The realism and integrity of Space Simulator are so complete that the more you learn about the physics and orbital mechanics of actual spaceflight, the more you'll enjoy your own explorations and the more realistic they'll seem.

After entering the Earth's atmosphere and practicing a landing at Cape Canaveral, we'll turn our thoughts upward again and take a closer look at such spaceflight basics as velocity, gravity, and orbital mechanics. We'll even visit Albert Einstein's theory of relativity.

Landing at Cape Canaveral

Our Earth is surrounded by a relatively thin and fragile layer of oxygen and nitrogen that we call the atmosphere. Although it is mostly invisible to us, with the exception of clouds, rain, and fog, it is extremely dense compared to the vacuum of space. Put your hand out the window of a car when you are driving down a highway, and you'll feel the pressure of the atmosphere against your hand.

A meteor (also called a shooting star) is simply the result of debris (from a speeding comet or other object) that slammed into our atmosphere, heated up from the resulting friction, and then burned into a fireball. Bear this in mind before trying to fly a spacecraft such as the shuttle, the F-79, or the all terrain lander (ATL) through our atmosphere. You don't want it to turn into a bright but short-lived shooting star.

Beginning Your Descent Half a World Away

For more information on orbital mechanics, see "Adjusting Perigee and Apogee" on page 172.

Orbital mechanics are such that the best place to begin your descent to the Shuttle Landing Facility at Cape Canaveral is when your spacecraft is on the opposite side of the Earth. You can practice descending into the Earth's atmosphere with Space Simulator's REENTRY situation.

For more information, see "Choosing Skill Level Preferences" on page 64.

Keep in mind that when you are flying at the practice skill level, you can enter the atmosphere at any speed. However, when you are flying at either the intermediate or advanced skill level, proceed with caution. Because of Space Simulator's realism, your spacecraft will burn up if it's traveling too fast by the time it reaches the upper atmosphere—that's about 63 kilometers above the Earth's surface.

To descend from orbit to the Shuttle Landing Facility

Remember, you can always press the PAUSE key if you want extra time to get ready for your next step.

Retroburn is the term often used to describe thrust applied in the opposite direction of travel. Retroburn slows your spacecraft down and consequently lowers your orbit as Earth's gravity affects your spacecraft. When you use a retroburn to leave your current orbit, it is called a deorbit burn.

1. From the Options menu, choose Open Situation.

   Space Simulator displays the Open Situation dialog box.

2. From the list, choose REENTRY, and then choose the OK button.

   Space Simulator places your spacecraft in a stable orbit at an altitude of about 390 kilometers above the surface of the Earth. Note that the time scale is at 0.001 seconds per second. This is to give you time to begin the situation without changing your orbital position.

3. From the Flight menu, choose Autopilot.

   Flight Simulator displays the Autopilot dialog box.

4. Under Action, choose Retrograde, verify that the current destination is Earth, and then choose the Execute button.

   The autopilot turns your spacecraft 180 degrees on its axis to prepare for the deorbit burn.

5. Press END or F8 to apply maximum thrust.

   Remember that because you are in a retrograde orientation, you are actually applying thrust in the reverse direction to slow your spacecraft.

6. Press F1 or click the up arrow on the time scale while watching the tangential velocity readout.

   Increasing the time scale speeds the loss of tangential velocity from the deorbit burn. Just don't go so fast that your velocity drops below 7.575 kilometers per second.

7. When the velocity readout displays 7.575 kilometers per second, press the HOME key or F5 to cut all thrust.

   This should provide you with an orbit low enough to bring your spacecraft near the Earth's surface in the vicinity of Cape Canaveral.

8. From the Flight menu, choose Autopilot.

   Flight Simulator displays the Autopilot dialog box.

9. Under Action, choose Prograde, verify that the current destination is Earth, and then choose the Execute button.

   The autopilot turns your spacecraft so that you are now facing Earth.

10 Press the SLASH (/) key or the ASTERISK (*) key on the keypad to roll your spacecraft until you can see the Earth's horizon at the bottom of your cockpit window, blocking out the background stars.

11 Pitch the nose of your spacecraft downward so that the Earth fills the bottom third of your cockpit window, and maintain this orientation as your ship continues to lower its orbit.

12 Press F1 or click the up arrow on the time scale to increase the time scale to about 8 seconds per second.

13 When the altitude readout drops to 70 kilometers, press SHIFT+F2 to reduce the time scale to 1 second per second.

H *Press to quickly turn the head-up display on or off.*

14 At an altitude of 63 kilometers, turn on the head-up display.

Note that the velocity readout shifts from tangential and radial velocity to ground and vertical velocity because at this altitude Space Simulator initiates atmospheric effects.

15 Adjust pitch upward to reduce downward vertical velocity to near zero, but use caution—pitch too high and you'll head back out of the atmosphere.

If this happens, the velocity readouts will switch back to display tangential and radial velocity.

You can always apply a little thrust to give your spacecraft the altitude it needs to reach the Shuttle Landing Facility. In real life, the shuttle glides all the way home, but with Space Simulator you can make adjustments when needed. As you get better, you'll be able to land while using minimal or no additional thrust.

16 Press ALT+R and change your reference object to the Shuttle Landing Facility (it's listed as a Surface object), and then choose the OK button.

17 Keep your vertical speed near zero as you close your distance to the Shuttle Landing Facility—you want to retain enough altitude to cover the remaining distance.

18 When your spacecraft is within 50 kilometers of the Shuttle Landing Facility, descend gradually.

Your altitude should be about 4 kilometers above the surface when you are within 12 kilometers of your destination.

To help you prepare for the final approach, press the PLUS SIGN key on the keyboard or click the Plus button on the view tools to increase the zoom control. Just remember to return the zoom to its normal setting of 2.00X when you are within a few miles of the landing strip.

19 Use the altitude readout and the head-up display to zero in on the Shuttle Landing Facility.

Good luck with your landing!

In time you'll get a feel for when to apply additional thrust to keep you going until you reach your destination, and when to apply additional retrograde thrust (or reverse fine thrust in an atmosphere) to hasten your loss of altitude.

You can experiment on your own to see how much of a retroburn you want for your landings. If you apply too much retroburn, you'll fall short of the landing strip. If you apply too little retroburn, you'll continue to orbit, although your orbit should become lower each time around.

Landing on Other Planets

When flying through a planet's atmosphere, your spacecraft experiences the same friction and drag as it would in real life.

You can experience the excitement and challenge of atmospheric landings on all the planets. As a general rule, Space Simulator begins atmospheric conditions at an altitude equal to one percent of the planet's radius. The friction of the atmosphere increases the nearer you get to the planet's surface, just as it does in real life.

Skipping Across the Atmosphere

The safest atmospheric entries are executed at a shallow angle of pitch to minimize velocity and friction. Taken to an extreme, a shallow entry is called aerobraking, which means that you don't land your spacecraft, but glance it off the upper atmosphere in order to slow it down. In fact, you can skip your spacecraft off an atmosphere like skipping a flat rock across water. You can try this with any of the planets that have atmospheres.

Taking a Closer Look at Velocity and Acceleration

To review the relationship between thrust, acceleration and velocity, see "Understanding Thrust, Acceleration, and Velocity" on page 18.

Velocity and acceleration are such integral parts of your space travels that it might be helpful to take a second look at them.

Using Velocity

Velocity is simply the constant rate at which an object moves from one point to another (for example, from Earth to Mars). Remember that within the great vacuum of interplanetary and interstellar space, there is no atmosphere or friction to slow an object down.

According to Newton's first law of motion, once an object (such as your spacecraft) is in motion, it won't slow down, speed up, or turn unless it is acted upon by another force, such as your engines, the gravitational pull of a star, or the atmospheric friction of a planet.

This constancy of velocity makes things easier for you when you are creating flight plans without using a flight computer. Simply divide the distance you plan to travel by your velocity, and you'll know the amount of travel time. For a more precise estimate, you can factor in the time required to achieve the velocity, and whether or not you will be applying reverse thrust to bring your spacecraft to a stop at the destination.

The velocity equation is:

velocity = [change in position] / time

So if you travel 100 meters in 10 seconds, your velocity is 10 meters per second (10 m/s).

Using Acceleration

Just as velocity can be described as the change in position divided by the change in time, acceleration is the change in velocity divided by the change in time.

Velocity shows the rate at which your position is changing. Acceleration shows the rate at which your velocity is changing. Any given level of acceleration produces a constant rate of change in velocity. For example, 1 gravity (G) provides an acceleration of about 10 meters per second per second, which means that for each second of travel you proceed at an additional 10 meters per second faster. This is true whether your source of acceleration is a spacecraft's engine or a planet's gravity.

The acceleration equation is:

acceleration = [change in velocity] / time

If your velocity changes by 25 meters per second, over a 5-second period, your acceleration is 5 meters per second per second, or meters per second squared (5 m/s^2).

Flying Without the Autopilot and Flight Computer

It can be challenging, but fun, to fly to distant destinations without relying on the autopilot or flight computer. There is tremendous satisfaction in flying from planet to planet, as if you were a Lindbergh in space, making daring passages all on your own. You can conduct many an expedition just by knowing the location and distance of your destination, and your spacecraft's velocity.

Using the Reference Object and Distance Readout as Your Guides

Remember that you must be in Cockpit view and in Panning mode with the panning bars centered to use the head-up display.

When you're out there flying on your own, the instrument panel provides you with two powerful navigational tools—the reference display and distance readout. The reference display shows the current reference object and the distance readout shows your distance from the reference object. To make getting places easy, set your destination as the reference object, and watch the distance readout to see how much farther you have to go. You can then use the attitude display and the head-up display to fly. The yaw, pitch, and roll readouts register zero when you are aimed directly for the reference object.

After you prepare for your voyage, all you need to do is to apply thrust. Give it a try with a flight from Earth orbit to the Moon. And just as a rocket scientist would do, turn your spacecraft around halfway there and reverse thrust so that you don't go shooting past your destination.

To prepare to fly from Earth to the Moon

1 From the Options menu, choose Open Situation.

  Space Simulator displays the Open Situation dialog box.

Test your piloting skills by flying in normal spaceflight. If you apply maximum thrust with Slew Control turned on, your spacecraft blasts into near light-speed.

2 From the list, choose FLIGHT, and then choose the OK button.

Space Simulator sets you up with Ring Station 1 right in front of you through your cockpit window and the Earth beyond.

3 Press ALT+R or click the reference display on the instrument panel.

Space Simulator displays the Select Reference Object dialog box.

4 Under Object Type, choose Moons, choose Earth's Moon from the list, and then choose the OK button.

The Moon is now your reference object, and the distance readout shows that it is about 406,000 kilometers away. (The actual distance varies depending on the time and date you begin your journey. The realism of Space Simulator is such that the Moon, Earth, and all other objects are always in motion.)

H *Press to quickly turn the head-up display on or off.*

5 From the Window menu, choose Show Head-Up Display.

Space Simulator superimposes the head-up display on your cockpit window.

Use the head-up display for approximate alignment with the reference object, while referring to the yaw, pitch, and roll readouts for exact values.

6 Using both the head-up display and the attitude display, zero your spacecraft in on the Moon. When making precision adjustments such as these, press the arrow keys sparingly and be ready to press KEYPAD 5 to stop rotation.

The closer the yaw, pitch, and roll readouts are to 00.00, the more perfectly you're aimed at your reference object (try to get the readouts within a few hundredths of a degree). This is especially important on long passages.

M *Press to display Map View or make it active.*

7 From the Window menu, choose Show Map View for an interesting reference during your trip to the Moon.

8 From the Window menu, choose View Controls.

Space Simulator displays the View Controls dialog box.

O *Press to quickly assign a map origin.*

9 Under View Controls For Window, choose Map View, and then choose the Map Origin button.

Space Simulator displays the Select Map Origin Object dialog box.

10 Under Object Type, choose Planets, choose Earth from the list, and then choose the OK button.

Space Simulator returns you to the View Controls For Map View dialog box.

11 Under Show On Map, turn off all objects except Planets, Moons, and Spacecraft, and then choose the OK button (a blank check box means you have turned an object off).

12 Press the PLUS SIGN key on the keyboard or click the Plus button on the view tools to zoom in so you can see the Moon, as well as the Earth, in Map View.

A zoom setting of 1.1 mkm (million kilometers) is good.

Now you are ready to take off. But remember that before applying thrust, it's a good idea to cancel all existing velocity.

To fly from Earth to the Moon

1 Press F4 to cancel all residual velocity.

For maximum realism, you can also cancel velocity by orienting your spacecraft 180 degrees from its current velocity vector and applying sufficient thrust to cancel its current velocity (the autopilot's Turnover action is helpful for making the 180-degree transition).

2 Press the END key or F8 to apply maximum thrust.

Be sure you aren't in Slew Control, or you'll blast past the Moon at nearly the speed of light.

The super adventurous can make the passage in real time. For more information on real-time piloting, see *"Piloting While You Sleep" on page 170.*

3 Press F1 a few times to increase the time scale to several seconds per second and reduce the time it takes to get to your halfway point of 200,000 kilometers.

4 Press SHIFT+F2 to decrease the time scale to 1 second per second as you get to within a few thousand kilometers of the halfway turnaround point.

You don't want to overshoot the halfway point, as you need to turn around and thrust in the opposite direction to slow your spacecraft for its arrival.

It's always a good idea to cancel all thrust before the turn around so that the blasting engines don't throw your spacecraft off course during the maneuver.

5 When you reach the halfway distance of 200,000 kilometers, press the HOME key or F5 to cut all thrust.

You can be more accurate if you like. If you started your journey 406,382 kilometers away from the Moon, you can turn around at a distance of 203,191 kilometers. (Be sure not to press F4; this would cancel all velocity, making things too easy, and quite unrealistic.)

After performing your 180-degree turnaround, you may want to change from Panning to Tracking mode in View 1, and then press the T key to set Earth's Moon as your tracking object. You'll lose your head-up display, but will be able to watch the approaching Moon through the back window of your spacecraft.

6 Use the arrow keys, the mouse, or a joystick to turn your spacecraft around until the yaw readout displays 180 degrees (both on the head-up display and the attitude display).

Your spacecraft is now facing away from the Moon, so that applying thrust will slow your spacecraft for arrival.

7 Adjust rotation as needed to keep yaw near 180 degrees, and pitch and roll near 00.00 degrees.

The more closely you keep your spacecraft aligned with the Moon, the more effective your thrusters are in slowing your lunar arrival.

8. Press the END key or F8 to apply maximum thrust.

   Because you've rotated your ship 180 degrees, this thrust slows the velocity of your spacecraft. Watch your radial velocity decrease.

9. When you are within about 35,000 kilometers of the Moon, press ALT+S to change the distance readout to radius and altitude.

   Remember that altitude shows how far away you are from the surface, while distance shows how far away you are from the center of the object.

10. When the radial velocity readout registers less than 500 meters per second, press HOME or F5 to cancel thrust.

    You should be quite near the Moon! Congratulations on making the passage!

If you'd like to establish a lunar orbit, see "Using the Orbital Velocity Table in Online Help" on page 171. Then maneuver your spacecraft to the proper altitude, cancel residual velocity, set yaw for 90 degrees, and apply thrust to achieve the velocity specified in the table.

Now you can either enter into a lunar orbit or set off for a new destination. Use the reference, distance, attitude, and head-up displays as your guides on journeys to other planets or distant stars.

A good practice to get into is to cut all thrust, and then cancel all existing velocity prior to beginning a trip. If you don't, you'll carry the velocity from the previous vector, or direction, all the way to the new destination. The longer the voyage, the more you'll be affected by residual velocity.

If you want to stop at your destination instead of flying past it, divide the distance in half and, when you reach the halfway point, turn your spacecraft around 180 degrees and apply an equal amount of thrust to slow your passage. Present-day spacecraft don't have the luxury of using continual thrust, as they simply can't carry enough fuel. Rocket scientists have earned their reputations by planning complex spaceflights and orbital transfers using only a minimal amount of fuel for each leg of the journey.

Using the Time Travel Charts

With Space Simulator it's easy to find out how far away an object is. Just make sure that your destination is the reference object, and check the distance readout for updates. You can also use the Time Travel Charts to figure out how long it will take your spacecraft to cover a given distance.

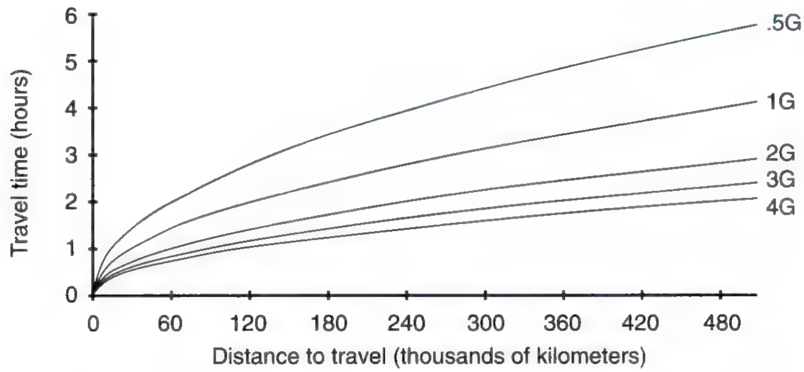
To see the ever-changing positions of the planets as they orbit the Sun, just display Map View and increase the time scale.

These charts are especially helpful because the planets, as well as all other objects in space, are constantly (even as you read this) changing their distance from one another as they each glide along their orbital paths. For example, Mars and Earth might be 390 million kilometers apart when in opposition (on opposite sides of the Sun from each other), and fewer than 85 million kilometers apart while in conjunction (closest together).

Use the Time Travel Charts to approximate travel times when you are applying a constant level of acceleration. When you are making long interstellar passages at maximum velocity (just below the speed of light), the conversion is even simpler. A trip of 50 light-years would take about 50 years!

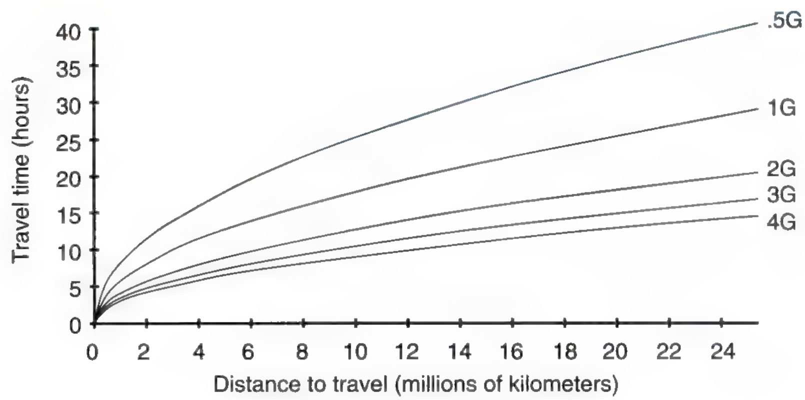
Time Travel Chart — For Traveling Thousands of Kilometers

This chart tracks traveling time for five different levels of acceleration: .5G, 1G, 2G, 3G, and 4G. Choose the acceleration curve for the number of gravities (Gs) you want to apply, and then take time readings at the intersection of the distance scale (along the bottom of the chart) and the time scale (along the left side of the chart).



Time Travel Chart — For Traveling Millions of Kilometers

This chart tracks traveling time for five different levels of acceleration: .5G, 1G, 2G, 3G, and 4G. Choose the acceleration curve for the number of gravities (Gs) you want to apply, and then take time readings at the intersection of the distance scale (along the bottom of the chart) and the time scale (along the left side of the chart).



Doing Your Own Math

If you really want to work at being a rocket scientist, you can determine the time required to cover a given distance at a constant acceleration by doing the math yourself. The basic equation follows.

$$T = \frac{\sqrt{2AD}}{A}$$

In the preceding equation, A represents the acceleration you'll be applying, D represents the distance you must travel, and T represents the time it will take.

If you want to stop at your destination, you'll need to decelerate during the second half of the voyage, which takes about 41 percent longer than accelerating all the way there. The following equation is the basis for the Time Travel Charts on page 169.

$$T = \frac{2\sqrt{AD}}{A}$$

You'll need a scientific calculator with exponential notation for these equations. Be sure to watch your units of measure as you'll have to convert years to seconds, gravities to meters per second squared, and so forth. If you like to play with numbers, you can make your trips more exciting and more satisfying by calculating the estimated time of arrival.

Piloting While You Sleep

Even when making real-time passages, it's okay to press F1 to increase the time scale. At nearly the speed of light, it would take you more than four years to reach Alpha Centauri. You would have to live, and keep your computer running, for more than 30,000 years to travel to the core of our galaxy!

Spacecraft of the future may provide a perfect haven for intensive dreamers. On long passages, dreams from the world of sleep will provide a release from the confines of the ship hurtling through the endless nights of space.

With Space Simulator, you can transfer yourself instantly from one point to the next with the Location menu, and you can make fast automated passages with the autopilot and flight computer. You can also begin your journey with Slew Control, travel quickly to within sight of your destination, and then return to Flight Control and fly the remainder of the voyage. But for those who want more of the real thing, crossing the voids of space may require "business as usual" while your spacecraft continues its journey.

Even when you increase the time scale, it can take days, weeks, months, or years to complete some passages. So, enjoy the realism! Set off on a journey and let your computer run all night as you sleep and all day as you work. Just make sure you're around for the big arrival. The closer you come to making real-time passages, the more you'll appreciate one of the singular mysteries of life—the unfathomable expanse of the universe.

Adjusting Orbits

To remember the difference between gravitational acceleration and momentum, think of gravitational acceleration as the gravity that tries to pull your spacecraft down. Think of momentum as the force that keeps your spacecraft moving in a straight line.

To understand how orbits are adjusted, it's a good idea to begin with a closer look at the two forces that interact during any orbital dance. Whether speaking of the Earth orbiting the Sun, or our Moon orbiting Earth, or a spacecraft orbiting a distant planet, the same two factors are in play: the gravitational pull of the central object (for example, the Earth) and the momentum of the orbiting object (for example, your spacecraft).

The gravitational pull that Earth (or any other object) places upon your spacecraft is called gravitational acceleration. Orbits exist only when the gravitational acceleration that seeks to pull your spacecraft down is balanced by the momentum that seeks to throw your ship away from the planet.

Balancing Gravitational Acceleration and Momentum

An orbit is similar to a dance in which both partners swing around with extended arms, neither coming closer together nor flying apart. But this orbital dance can be thrown off balance.

When you reduce momentum—for example, if your spacecraft is in a low orbit and is slowed by the friction of the upper atmosphere—the balance is lost and your spacecraft tumbles back to Earth.

When you increase momentum—for example, if you apply too much thrust—your spacecraft breaks free of the gravitational pull and soars off into space. This is called achieving escape velocity.

Considering the Law of Universal Gravitation

Sir Isaac Newton's law of gravitation states that all objects in the universe attract each other with a force that is proportional to their mass, and inversely proportional to the square of the distance between them.

This means that the more massive an object is, the more gravitational acceleration it exerts from the same distance, and that the farther away you are from a planet or other object, the weaker the gravitational acceleration will be. If you double your distance from the object, the gravity will be one fourth as strong.

Using the Orbital Velocity Table in Online Help

Remember that you can always automate the orbiting procedure by using the orbit action in the autopilot. But there's great satisfaction in establishing your own orbits using the orbital velocity table.

Math mavens can use the gravitational constant to calculate orbital information. But in Space Simulator, you can use the orbital velocity table provided in online Help.

To use the orbital velocity table in online Help

1. From the Help menu, choose Basic Skills.

   Space Simulator displays the Basic Skills Help dialog box.

2 Choose the Spaceflight Skills button.

Space Simulator displays the Spaceflight Skills dialog box.

3 Choose Orbital Velocity Table, and then choose the OK button.

The orbital velocity table shows the tangential velocity required for a stable orbit at various altitudes above different planets and moons.

For added realism, you can also cancel existing velocity with retroburns. For more information on retroburns, see the procedure "To descend from orbit to the Shuttle Landing Facility" on page 162.

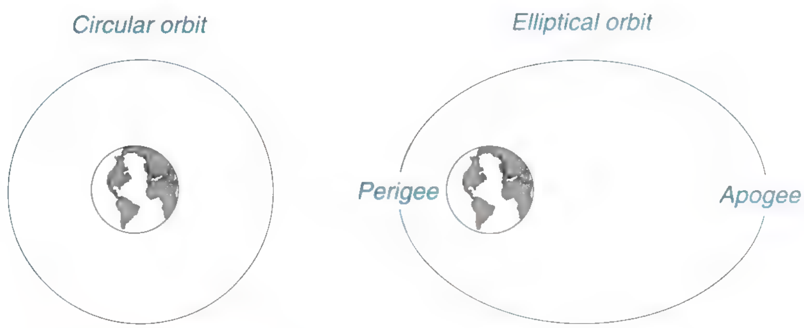
So leave the autopilot behind and achieve a stable orbit using the orbital velocity table. It's a simple matter of positioning your spacecraft the desired number of radii above the surface, using the yaw readout or the head-up display to orient your ship to either +90 degrees or -90 degrees of your reference object, and applying thrust to achieve the tangential velocity required for a stable orbit. There's just one thing to remember—before applying the thrust to begin your orbit, press F5 to cancel all thrust, and then press F4 to cancel your existing velocity!

Adjusting Perigee and Apogee

Eccentricity for closed orbits is a value between 0 (zero) and 1, in which a perfect circle is a value of 0, and an extremely elliptical orbit is near a value of 1. An eccentricity of 1 or higher is given to open parabolic and hyperbolic orbits that never close back on themselves.

Although the Earth's orbit is very near to being perfectly circular, its orbit—as well as the orbit of all the other planets in our solar system—is elliptical (oval in shape). The degree to which an orbit is elliptical is referred to as eccentricity. Pluto's orbit, which is the most elliptical planetary orbit in our solar system, has an eccentricity of 0.248. Earth's nearly circular orbit gives it just a slight eccentricity of 0.017.

Perigee is the term used to describe the closest approach an object makes to the body it is orbiting. Apogee marks the farthest point in the orbit, after which the gravitational acceleration of the body brings the orbiting object back. The greater the difference between the apogee and perigee, the greater the eccentricity (or elliptical shape) of the orbit.



Apogee and perigee are the same in a circular orbit.

For more information, see "Altering Your Orbit with Prograde and Retrograde" on page 128.

For an insight into orbital mechanics, toss a ball straight up into the air. Initially, the ball has quite a bit of velocity, but, as it goes higher, the gravitational acceleration of the Earth begins to pull it back. The ball's velocity is slowest at the point of apogee, when it is the farthest away. As it begins to fall back toward you, its velocity increases with gravity, and it reaches its greatest velocity at perigee, when it returns to your hands.

The same is true for a spacecraft orbiting a planet and for a planet orbiting a star. The orbiting object loses velocity as it travels toward apogee, and gains velocity as it comes back toward perigee. In Space Simulator, you can watch this happen on the velocity readouts.

Raising an Orbit

When working with orbits and orbital transfers, choose Preferences from the Options menu, choose Precision, and set the simulation precision scale toward the high end. A setting of 8 gives the most precision.

The proper term for raising an orbit is increasing its eccentricity, which means that the orbit is made more elliptical, giving it a farther reach. You can increase an orbit's eccentricity by applying prograde thrust at the point of perigee. This provides additional energy for your spacecraft as it heads back out toward apogee. The point of perigee remains the same, but the point of apogee becomes farther away. Do this often enough and you can extend an orbit from the Earth to the Moon . . . or to Mars and beyond. This process is called a Hohmann transfer, in honor of the person who suggested this method of space travel.

Circularizing an Orbit

You can decrease the eccentricity of an orbit, and hence make it more circular, by applying prograde thrust at the point of apogee. This is called an apogee kick, and results in a rounder and larger orbit. You can combine an apogee kick with a perigee burn to increase the total size of an orbit. You can use this process to fly your spacecraft from one object to another object—for example, from Earth to Jupiter.

Retrofiring to Decrease an Orbit

When preparing for a retroburn, you can turn your ship around manually, using the yaw readout or the head-up display as your guide. You can also use the retrograde action in the autopilot.

Another form of the Hohmann transfer is to retrofire at perigee to decrease the velocity of your spacecraft and lower its orbit. Retrofiring is accomplished by turning your ship 180 degrees so that its engines are facing your direction of travel. Apply thrust now, and you'll slow your spacecraft. A retrofire application of thrust with sufficient impulse to lower perigee to the surface is sometimes called a deorbit burn.

Changing Orbits with a Hohmann Transfer

For more information on orbital mechanics and space travel, see "Spaceflight Books" on page 176.

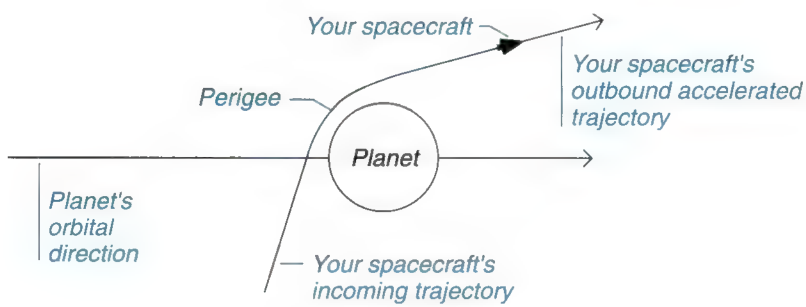
Much of current-day spaceflight is based on the Hohmann transfer because it is such a fuel-efficient method of space travel, and fuel is always a valuable commodity in space because it must be carried out of Earth's gravity well. There can be quite a bit of math involved in executing a perfect Hohmann transfer, but you can get a feel for it by setting up Map View with the Sun as the map origin, and then applying apogee kicks and perigee burns to boost your orbit from Earth's to that of Mars. Start off by applying thrust for only a few seconds, and then watch the results. Be careful not to blast yourself out of the solar system. To keep your map clear, turn off everything except stars, planets, and spacecraft. You'll also want to advance the time scale to see the planets in motion, but always remember to return the time scale to 1 second per second before applying thrust, otherwise you'll thrust yourself out of orbit.

Executing Gravitational Slingshots

Another wonder to watch in Map View, as well as to monitor with your velocity readouts, is the gravitational acceleration you can pick up when flying past a planet or other massive object, especially when approaching it from behind. The gravity of the planet draws your spacecraft toward it and increases your velocity, which accelerates you into a higher orbit relative to the Sun. Because your spacecraft has greater than escape velocity, it follows a hyperbolic trajectory past the planet.

This is called a gravitational slingshot effect. During the maneuver, your tiny spacecraft steals momentum from the planet, which actually slows it down, even though the amount is imperceptible. If you were flying a Moon-sized spacecraft, however, you could wreak havoc with the orbit of the planet you were slingshotting with.

The Slingshot Maneuver



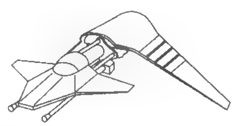
Understanding Relativity

In 1905 the brilliant German physicist, Albert Einstein, who was working as a clerk in the Swiss patent office, published his first theory of relativity, in which he proposed that $E=MC^2$ (energy is equal to mass times the speed of light squared), and created the speed limit that still stands—nothing can travel faster than the speed of light. This came to be known as his special theory of relativity. The word special is used because in his first theory he didn't address gravitational effects and acceleration.

Ten years later, Einstein wrote his general theory of relativity, and neither time nor space has seemed the same since. In the general theory, he considered the effects of gravity and acceleration and proposed a space-time continuum in which the fabric of space and time was warped by the gravitation exerted by massive bodies such as stars and planets.

Together, Einstein's theories of relativity have made time into a mercurial entity that varies for each observer, depending on location and speed of travel.

All the instruments in Space Simulator are based on an Earthbound frame of reference, so acceleration, velocity, and time are all shown as viewed from Earth. Although Space Simulator functions in a Newtonian rather than a relativistic fashion, it shows the effects of relativity by decreasing your spacecraft's acceleration as it approaches the speed of light, which is what an observer on Earth would see. What Space Simulator doesn't show is the time dilation (time slowing) effects on the spacecraft in space.



You now have all the knowledge you need to become a galactic explorer, a traveler of the stars. Enjoy your journeys and travel far!

Chapter 15
More Information About Space

"My mental boundaries expanded when I viewed the Earth against a black and uninviting vacuum, yet my country's rich traditions had conditioned me to look beyond man-made boundaries and prejudices. One does not have to undertake a space flight to come by this feeling."—Rakesh Sharma, Indian astronaut (from The Home Planet)

To order the Microsoft Press companion book for Space Simulator, in the USA, call 1-800-MSPRESS.

In this chapter, you'll learn how to

- Find more information about space travel.

Space Simulator opens a doorway to the wonders of space and the promise of space development. As surely as Leif Erickson, Christopher Columbus, and Ferdinand Magellan set off in search of new worlds, someday soon humans will venture farther into space. Until then, Space Simulator provides you with the tools and the opportunity to realize your dreams of space exploration. If you want more information about spaceflight, space development, or astronomy, here are some excellent resources.

Spaceflight Books

Spaceflight is unlike anything experienced on Earth. To get an idea of what awaits you, take a look at the following books.

- ***Chariots For Apollo: The Making of the Lunar Module,*** Charles R. Pellegrino and Joshua Stoff, New York: Atheneum Publishers, 1985. An insightful account of space exploration.
- ***How Do You Go to the Bathroom in Space and Other Questions,*** William R. Pogue, Rev. ed., New York: Tor Books, 1991, © 1985. An enjoyable look at the way things work in space.
- ***Introduction to Space: The Science of Spaceflight,*** Thomas Damon, Malabar, Florida: Orbit Book Company, 1989. A tremendous tutorial on the physics of propulsion and orbital mechanics. If you want to increase your ability to fly without the autopilot and flight computer, this is an excellent source.
- ***The Home Planet,*** Kevin W. Kelley, editor, New York: Addison Wesley, 1988. A beautiful, large-format collection of space photographs, interspersed with quotations from astronauts.

- ***The Mars One Crew Manual,*** Kerry Mark Joëls, New York: Ballantine Books, 1985. A fascinating trip to Mars, covering everything from storing supplies to orbital transfers, landings, exploration, and scientific experiments. Joëls worked closely with scientists at the National Aeronautics and Space Administration (NASA), the Jet Propulsion Laboratory, the California Space Institute, and Lockheed to create a plan so detailed it should be put into action.
- ***The Right Stuff,*** Tom Wolfe, New York: Farrar, Straus & Giroux, 1979. This book explores the heroics and hassles of the early American space program.
- ***The Space Shuttle Operator's Manual,*** Kerry Mark Joëls, New York: Ballantine Books, 1982. A captivating look inside the space shuttle program, explaining everything from eating and bathing in space to detailed step-by-step instructions for space walking. Extensive photographs and drawings.

Space-Development Books

Space is immense and essentially limitless, but you can begin to explore what it has to offer without traveling too far from home. Here are some excellent books on the riches (both material and existential) of our solar system.

- ***Colonies in Space,*** Thomas A. Heppenheimer, Harrisburg, PA: Stackpole Books, 1977. A study of how to construct colonies in space and why we should already be working on this.
- ***Handbook of Soviet Manned Space Flight,*** Nicholas L. Johnson, San Diego: American Astronautical Society, Univelt, Inc., 1980. A great source of spaceflight information.
- ***Out of the Cradle: Exploring the Frontiers Beyond Earth,*** William K. Hartmann, Ron Miller, and Pamela Lee, New York: Workman Publishing, 1984. An imaginative journey into space that makes you want to leave planet Earth.
- ***Pioneering Space: Living on the Next Frontier,*** James E. Oberg and Alcestis R. Oberg, New York: McGraw-Hill Book Company, 1986. A persuasive and logical case for human space travel. The spirit of the book is expressed in its dedication: "To our ancestors, who brought us to this threshold, and to our descendants, who cross over it."
- ***Pioneering the Space Frontier: The Report of the National Commission on Space,*** New York: Bantam Books, 1986. Created by Congress and appointed by President Reagan, the National Commission on Space was designed to formulate an aggressive civilian space agenda and to carry America into the 21st century. The Commission did magnificent work, and it is now up to the rest of us to see that it is carried out. An informative book, beautifully illustrated with photographs and paintings.

- ***Space in the 21st Century,*** Richard S. Lewis, New York: Columbia University Press, 1990. A compilation of information and illustrations about our future in space.
- ***The Grand Tour: A Traveler's Guide to the Solar System,*** Ron Miller and William K. Hartmann, New York: Workman Publishing, 1981. A travel guide, illustrated with stunning space art.
- ***The High Frontier: Human Colonies in Space,*** Gerard K. O'Neill, New York: William Morrow & Company, Inc., 1977, © 1976. During his life as a professor of physics at Princeton University, O'Neill's research and writing planted seeds of space exploration that may come to fruition in the near future.
- ***The Overview Effect: Space Exploration and Human Evolution,*** Frank White, Boston: Houghton Mifflin Company, 1987. Insights from astronauts about how space travel changed their lives. See the Earth from their perspectives.

Astronomy Books

From theoretical research to sightseeing, astronomy is a magnificent pursuit and offers a window into the mysteries of the universe. The following books provide excellent guidance.

- ***A Brief History of Time: From the Big Bang to Black Holes,*** Stephen W. Hawking, New York: Bantam Books, 1988. A voyage into the mysterious realms of space by the most brilliant theoretical physicist since Einstein.
- ***A Complete Manual of Amateur Astronomy,*** P. Clay Sherrod and Thomas L. Koed, Englewood Cliffs, NJ: Prentice-Hall, 1981. A great source book for the amateur astronomer.
- ***Astronomy for Children Under Eighty,*** John Dobson, 1801 Golden Gate Avenue, San Francisco, CA 94115, 1973. A spiritual look at astronomy (by the creator of the Dobsonian telescope mount), offering insights into what may have preceded the theoretical Big Bang.
- ***Atlas of the Heavens,*** Antonin Becvar, Publishing House of the Czechoslovak Academy of Sciences, 1962, distributed by Sky Publishing, Cambridge, MA. A source for the serious amateur astronomer, covering the sky down to magnitude 7.2.
- ***Burnham's Celestial Handbook: An Observer's Guide to the Universe Beyond the Solar System,*** Robert Burnham, Jr., New York: Dover Publications, Inc., 1966, 1978. A magnificently illustrated, three-volume work that mixes mythological, historical, and astronomical information to give the reader an enchanting tour through the skies.
- ***Cosmos,*** Carl Sagan, New York: Random House, 1980. A well-written and nicely illustrated book on astronomy and space.

- ***New Horizons in Amateur Astronomy,*** Grant Fjermedal, New York: Perigee Books, The Putnam Publishing Group, 1989. An enjoyable look at the major contributions that amateurs make to the field of astronomy. Includes interviews with passionate comet hunters relating their love for the night sky and their excitement at being the first to discover ancient visitors from above.
- ***Norton's Star Atlas and Reference Handbook, 17th ed. rev.,*** Arthur P. Norton, London: Longman Scientific and Technical, 1986. A classic atlas, first published in 1910, that provides an excellent guide to the stars, covering the sky down to magnitude 6. It belongs in the library of every serious and traditionally minded astronomer.
- ***Starlight Nights: The Adventures of A Star-Gazer, 2nd ed.,*** Leslie C. Peltier, Cambridge, MA: Sky Publishing, 1980, © 1965. A joy to read, this book provides insight into the inspiration and happiness a person can derive from looking at the stars.
- ***The Amateur Astronomers' Handbook, 3rd ed.,*** James Muirden, New York: Harper & Row, 1987, © 1983. A great source of practical, hands-on amateur astronomy.

Space-Development Organizations

If you want to learn more about space, space development, or astronomy, here is a listing of organizations.

- ***Astronomical Society of the Pacific,*** 390 Ashton Avenue, San Francisco, CA 94112. This organization of professional and amateur astronomers publishes a monthly magazine to keep its members up to date on developments in the sky.
- ***International Space Exploration and Colonization Company,*** P.O. Box 60885, Fairbanks, AK 99706-0885. This nonprofit organization's goal is to aid in the exploration and colonization of space. Current research is centered on the construction of a closed ecological life-support system and cost-effective, efficient means of supporting life in outer space.
- ***The Planetary Society,*** 65 North Catalina Drive, Pasadena, CA 91106. Founded by physicist Carl Sagan, and former head of the Jet Propulsion Laboratory, Bruce Murray, this group is dedicated to promoting space development and publishing information about space exploration and the search for extraterrestrial life.
- ***The National Space Society***, 922 Pennsylvania Avenue SE, Washington, DC 20003. This grass-roots organization, dedicated to promoting space exploration, has chapters in all states and in 40 countries. The organization was created several years ago when the L-5 Society merged with the National Space Institute. It publishes a bimonthly magazine.

- ***National Aeronautics and Space Administration,*** Johnson Space Center, Public Services Branch, Mail Code AP4, Houston, TX 77058. NASA's public services branch is a great source for information and visuals that show where we've been and where we are going.
- ***Space Studies Institute,*** P.O.Box 82, Princeton NJ 08542. Founded by Gerard K. O'Neill, former professor of physics at Princeton University, the goal of this nonprofit research and education organization is to harness the resources and technology of space for the benefit of humankind on Earth.

Chapter 16
Common Questions and Answers

"A strange feeling of complete, almost solemn contentment suddenly overcame me when the descent module landed, rocked, and stilled. The weather was foul, but I smelled Earth, unspeakably sweet and intoxicating. And wind. How utterly delightful; wind after long days in space."—Andriyan Nikolayev, Russian astronaut (from The Home Planet)

In this chapter, you'll learn how to

- Set up Space Simulator so it runs best on your computer.
- Adjust the memory configuration.
- Increase your computer's performance.
- Understand how video modes and sound affect Space Simulator.
- Get answers your questions.

Setup

For tips on troubleshooting during Setup, see the "Troubleshooting Guide for Setup" on the inside back cover of this book.

Q: Can I run Space Simulator from Microsoft Windows?

A: Space Simulator performs best when it is the only program running. For this reason, we recommend that you run Space Simulator from MS-DOS instead of from Microsoft Windows.

Q: How much disk space do I need to install Space Simulator?

A: Space Simulator requires 15 MB disk space and must be installed on a hard disk.

Q: How do I modify Setup after I've installed Space Simulator?

A: From the Options menu, choose Exit. At the MS-DOS prompt (from within the SPACESIM directory), type **setup**. Change your original configuration as you run the Setup program.

Memory

Q: What do I need to know about memory and Space Simulator?

A: Space Simulator uses two types of memory: conventional and expanded memory.

Conventional memory is memory in the range of zero to 1 MB. The first IBM-compatible PCs (8088/8086) could only address up to 1 MB of memory at a time. Only 640K of this space actually contains physical memory (RAM). The other 384K is reserved for computer hardware device drivers such as video cards and the ROM BIOS (which controls the basic functions of a computer).

Expanded Memory (EMS) is a type of physical memory on IBM PCs and compatible microprocessors. Expanded memory requires an interface called the Expanded Memory Manager (EMM), which maps pages (blocks) of bytes from expanded memory onto reserved areas called "page frames" in the conventional memory area.

For tips on how to configure your computer for more expanded memory, see the "Troubleshooting Guide for Setup" on the inside back cover of this book.

Q: Why do I need expanded memory for Space Simulator?

A: Space Simulator runs best using 768K of expanded memory to store photo-realistic images such as planet and moon surfaces and deep sky objects (however you can run it with as little as 512K). If you have a sound card, Space Simulator uses up to 21K conventional memory and an additional 64K of expanded memory to produce sound effects.

Q: How much memory do I need for Space Simulator?

A: To run Space Simulator you need 550K free conventional memory and 768K or more free memory configured as expanded with an expanded memory driver. If you have a 2 MB computer, configure as much as possible as expanded memory—at least 1024K EMS—this will greatly enhance the display rate on your computer.

Q: How do I determine how much free memory my computer has?

A: Since Space Simulator only supports MS-DOS 5.0 or later, type **mem** at the MS-DOS prompt for a list of conventional, XMS, and EMS memory.

The memory configuration issue is complicated. Even PC experts have trouble with it. The new memory manager and MEMMAKER auto-configuration utility in MS-DOS 6.0 or later will set up your computer's memory configuration for optimal performance.

Q: How do I configure my computer's memory as expanded?

A: With MS-DOS versions 5.0 and later, use the EMM386 utility to make expanded memory available on 80386 and higher computers. Basically, you need to make sure that the CONFIG.SYS says EMM386.EXE RAM 768. To learn more about EMM386, see the "Troubleshooting Guide for Setup" on the inside back cover of this book. If you use other EMM programs, consult their documentation for configuration instructions.

With MS-DOS version 6.0 or later, use the Memmaker utility to configure your computer for optimum performance. It is designed to help you free up memory and configure your system for expanded memory. For specific instructions, see the "Troubleshooting Guide for Setup" on the inside back cover of this book.

Performance

Q: What type of computer is recommended to run Space Simulator?

A: Space Simulator will run on 80386, 80486, and Pentium computers. The required configuration is an 80386 or higher computer running at 25 MHz, with 768K configured as expanded memory.

The recommended configuration for best performance is an 80486 or higher computer running at the highest MHz possible. It is important to remember that the faster the computer, the better the video performance and response time will be.

Q: Space Simulator runs slowly and the action is not smooth. How can I improve video performance and response time?

A: Overall, the faster the computer, the better the video performance and response time will be. The following settings offer a nice tradeoff between image quality and frame rate.

- From the Options menu, choose Preferences, and then choose the Scenery category. In the Scenery Preferences dialog box, set the Star Limiting Magnitude to 6.
- From the Options menu, choose Preferences, and then choose the Scenery category. In the Scenery Preferences dialog box, make sure that the Milky Way check box is turned off.
- From the Options menu, choose Preferences, and then choose the Rendering category. In the Rendering Preferences dialog box, turn on the Sparse check box for less detail.
- From the Options menu, choose Preferences, and then choose the Rendering category. In the Rendering Preferences dialog box, turn on the Solid check box for solid pixels.
- From the Options menu, choose Preferences, and then choose the Rendering category. In the Rendering Preferences dialog box, turn on the Smooth check box.
- From the Options menu, choose Preferences, and then choose the Precision category. In the Precision Preferences dialog box, set the Simulation Precision as low as possible. For the most common flying techniques, you won't need a high rate of simulation precision.

- From the Options menu, choose Exit. At the MS-DOS prompt (from within the SPACESIM directory), type **setup**. Change your original configuration as you run the Setup program. For example, if you have an 80386 computer, change to VGA 320x400.

Video Display

Q: What video modes are available and which one should I choose?

A: Space Simulator 1.0 supports the following video modes:

- VGA 320x400 256 colors
- SVGA 640x400 256 colors
- SVGA 800x600 256 colors

Most VGA cards work with the VGA 320x400 256-color video mode.

Many SVGA cards can use the 640x400 256-color video mode or 800x600 256 colors.* Space Simulator supports the following video cards in these modes:

- VESA 1.2 compatible***
- ATI 18800, 28800, Mach-32 (ATI VGA Wonder / Wonder+ / Wonder XL / ATI UltraPro)
- Video 7/Headland Technology (Video 7 1024i / Fastwrite / VRAM / VRAM II)
- Tseng ET 4000 (Orchid Prodesigner II / STB Powergraph II / Diamond Speedstar / Speedstar Hicolor / Speedstar 24)**
- Trident 8900 (TVGA)**
- Paradise (PVGA / Diamond Speedstar 24X)
- S3 8801, 805, 911, 928 (Orchid Fahrenheit 1280)**
- Cirrus Logic 542X (MV Thunder & Lightning / Diamond SpeedStar Pro)**
- Trident 8900 (TVGA Alternate)**

* SVGA 800 x 600 256 colors requires 1 MB of video memory.

** The Tseng Labs ET-4000, Trident 8900, Cirrus Logic 542X, and S3 86C11 are graphics chips found in many popular video cards. Consult your video-card documentation to determine if your card is based on one of these chip sets. Manufacturers have variations on current and new chip sets that may not be in the above list. Because of internal manufacturing standards, a video mode for one chip will often work well on another current or future chip. For example, the S3 86C11 mode works well on an S3 805 chip set.

*** Some VESA 1.2 compatible video cards may not run with Space Simulator.

If you have incorrectly installed your sound card and sound-card software, Space Simulator will not run properly. Consult your sound-card documentation for installation instructions.

Q: While running the Setup for Space Simulator, I can't find the name of my SVGA card in the list of SVGA choices. What should I do?

A: If you can't find your SVGA card in the list while running Setup, try the other choices (if you choose an incorrect card, it will be obvious from the mismatching colors on the screen). If none of the SVGA choices work, choose VGA 320x400—Space Simulator will run on any card offering VGA 320x400.

Q: What can I do if I'm unable to use my SVGA card?

A: Consult the documentation for your video card or contact the manufacturer—they may be able to send you a driver program that will enable you to use your video card with Space Simulator. Remember that you can always use the VGA 320x400 video mode to run Space Simulator.

Sound

Q: Do I need a sound card to hear sound effects in Space Simulator?

A: Yes, Space Simulator provides support for 0PL2 (AdLib) compatible sound cards.

Q: How do I adjust the volume?

A: You cannot adjust the volume in Space Simulator. If you need more information on volume control, consult the documentation for your sound card.

Q: Why are the sound effects for Space Simulator distorted or not working?

A: When you install Space Simulator, Setup suggests factory defaults for your type of sound card. If you are sure that the default sound card is correct, you may need to change the Interrupt and/or the Base Address settings. Consult the documentation that came with your sound card to determine what the correct settings are.

Space Simulator Tips

Q: Why does the nose of my spacecraft pitch down when I press KEYPAD 8 and pitch up when I press KEYPAD 2?

A: In Space Simulator, the keyboard pitch controls are initially set to simulate those of a real spacecraft—you push the controls forward to pitch down (KEYPAD 8 or UP ARROW) and pull the controls back to pitch up (KEYPAD 2 or DOWN ARROW). You can change the pitch control functionality by choosing Preferences from the Options menu, and then choosing Keyboard to reassign keys for the pitch-down or pitch-up controls.

Q: Why does it take my spacecraft so long to change direction after I turn it? The front of the ship faces in the new direction, but it keeps going in the previous direction.

A: You are experiencing the exacting reality of how a spacecraft really responds to a change in thrust direction in the vacuum of space. In effect, you are spinning out, as if trying to turn on ice. For more information on steering your spacecraft, see "Steering Your Spacecraft with the Rotation Gauge and Attitude Display" on page 26.

For less realistic, but much more responsive steering, choose Slew Control from the Flight menu. Then you can spin on a dime. For more information, see "Slewing Through Space" on page 46.

Q: When I try to turn my spacecraft in Chase view, everything turns except my ship—it stays in a straight line as Earth and the stars rotate by. Why can't I see my spacecraft turn?

A: Press the B key to shift the chase craft perspective from relative to absolute. Relative perspective means that your chase craft view is relative to your spacecraft—as if watching from a camera connected to your spacecraft. Absolute perspective means the chase craft view is at an absolute location apart from your ship. This is why you can see your own spacecraft turning. For more information, see "Controlling Views" on page 16.

Q: Why do the Moon and Sun appear as only small dots in Space Simulator while they seem so big when we view them from Earth?

A: Human vision works with a fish-eye effect—we see well in the direction we are looking (a relatively small field of view), but we have poor peripheral vision. Space Simulator represents your entire field of view with the same visual quality—as a result, objects often look smaller than you expect. A little math shows that the Moon takes up less than 0.5 percent of our field of view, which is translated into only a pixel or two on Space Simulator's viewing window. To see the Moon as you do at night from your own backyard, you need to increase the zoom magnification on Space Simulator's view tools to around 15X. There are also some small atmospheric effects that cause objects to appear larger than they really are when viewed from Earth.

Q: When I'm orbiting an object such as in the FLIGHT situation, I am thrown out of orbit as soon as I increase to high time scales. Why?

A: Space Simulator has to estimate a number of things in order to provide acceptable performance. As a result, there are approximations in the flight calculations that don't work well at high time scales, particularly on slower computers. If you are willing to view Space Simulator at a slower frame rate, you can make the flight calculations in Space Simulator more precise (even at high time scales). Choose Preferences from the Options menu, and then choose the Precision category. In the Precision Preferences dialog box, set the Simulation Precision to a higher setting. A setting of 8 is the highest, but this will slow the performance of Space Simulator. Even with the Simulation Precision set for 8, it is possible to increase the time scale so high that you will be thrown out of orbit.

Q: I was in the middle of a long trip when I decided to use the Set Location command on the Location menu to get back to Earth. When I did, I was instantly pulled right up against Earth's surface. What happened?

A: The Set Location command does not modify your time scale or put you in orbit. So if you increase the time scale significantly, and then choose the Set Location command on the Location menu to set your location to Earth, several years can pass in a matter of seconds. As a result, you are pulled into the Earth—you actually go there immediately. Decrease the time scale on the instrument panel to 1 second per second, and try setting your location to Earth again. The time scale is a powerful, yet tricky feature, so be careful with it.

Q: Sometimes when I'm approaching a planet or another object, it will start as a small dot, grow to a small circle, and then disappear. Why does this happen?

A: You have approached the dark side of the object. The pictures of the planets are very complicated objects to draw, and so rather than drawing objects that are so far away you can't see any details, Space Simulator simply puts dots on the screen to represent them. As you get closer to an object, the dots get bigger until it's time to actually start drawing the true picture of the object. When this occurs, the shadowing algorithms kick in, and you see the true image of the object, but sometimes you don't see anything at all because you just happen to be the dark side of the object.

Q: Why does my head-up display rotate when I'm heading for Ring Station 1 or the Mars Orbiter? Am I spinning around?

A: The vertical scale of the head-up display (HUD) rotates at the same rate of rotation as Ring Station 1 or the Mars Orbiter (when either is your reference object). This can be distracting, but you can stabilize the rotation by pressing the F2 key to slow the passage of time to just a fraction of a second per second. The F1 key increases the passage of time. You can press F1 and F2 to get the HUD's vertical scale straight up and down on the screen, and then adjust your spacecraft's pitch. Note that the vertical scale zeros in on the center of Ring Station 1. If you want to dock with the station, head for the orange docking port at the very bottom of the space station.

Q: How do I find out the correct altitude and velocity to maintain an orbit around a planet?

A: For more information on altitudes and orbital velocities, choose Basic Skills from the Help menu, choose the Spaceflight Skills button, and then choose Orbital Velocity Table.

Appendix A
Using the Keyboard, Mouse, and Joystick

"As we encounter the thin upper reaches of the atmosphere, the orbiter begins a gradual transition from ballistic orbital object to aerodynamic flying machine. The first clue comes as the wings bite into the air producing an acceleration that causes you to sink into the seat cushion. You hear wind noise around the windshield which slowly increases; then you feel an occasional tremor from turbulence. Gradually the impulses from the control jets become unnoticeable and the familiar feeling of aerodynamic flight is complete."—Gordon Fullerton, American astronaut (from The Home Planet)

In this appendix, you'll learn how to

- Fly into outer space using the keyboard, mouse, and joystick.
- Install, test, and calibrate your joystick.

In Space Simulator, you can fly your spacecraft and enjoy your surroundings using the keyboard, mouse, or joystick. Decide for yourself which controls work best for you.

You can also adjust the sensitivity of the keyboard, mouse, and joystick to customize their response rates.

This appendix includes information on how to get the most enjoyment from the keyboard, mouse, and joystick. It tells you where to get information on adjusting sensitivity controls, and includes instructions for installing and calibrating a joystick.

Using the Keyboard

For a convenient review of all Space Simulator's keyboard shortcuts, choose Keyboard Guide from the Help menu, and then choose the Keyboard Shortcuts button.

Space Simulator has a wealth of keyboard shortcuts designed specifically to make all your commands and maneuvering transitions as smooth as possible. Identify the keyboard shortcuts that you find most significant for your own adventures within Space Simulator, and then integrate them with regular use.

If you prefer using the keyboard and keyboard shortcuts to simplify your controls, see the "Keyboard Quick Reference" on the back cover of this book.

For information on changing keyboard sensitivities, see "Adjusting Keyboard Preferences" on page 62.

Using the Mouse

You can change the sensitivity settings for the mouse. For more information, see "Adjusting Mouse Preferences" on page 63.

In Space Simulator, you can use the mouse in Pointer mode and Yoke mode. This section explains the differences between these two modes and describes how to use the mouse to control your spacecraft.

Click the right mouse button to switch between Pointer and Yoke modes.

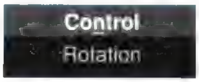
Pointer Mode

In Pointer mode, Space Simulator displays a pointer on the screen. You can choose menus and options by clicking them with the left mouse button. You can also open some dialog boxes by clicking different areas of the instrument panel. For example, click the word Reference on the instrument panel to open the Select Reference Object dialog box.

Yoke Mode

If the Joystick is active, it overrides the mouse yoke controls.

In Yoke mode, you use the mouse in conjunction with the control readout in the lower-right corner of the instrument panel to fly your spacecraft, use your telescope, and change your views. You can control yaw, pitch, roll, fine thrust, and panning with the mouse, but you can only control main thrust with the keyboard.



When the control readout is set on Rotation, you move the mouse forward or backward to control spacecraft pitch (nose down or up). You move the mouse left or right to control yaw (left or right turn). You hold down the CTRL key and move the mouse left and right to control roll (both when flying and when at the observatory). The rotation gauge on the instrument panel responds as you move the mouse.

When the control readout is set on Thrust, you move the mouse forward or backward to control downward or upward fine thrust. You move the mouse left or right to control left or right fine thrust. The fine-thrust gauge on the instrument panel responds as you move the mouse. Note that you cannot control forward or backward fine thrust with the mouse.

When the control readout is set on Panning, you move the mouse in the direction in which you want to pan. In Cockpit, Chase, and Assigned views, you can pan in any direction and see all around you. This viewing flexibility is called power panning. The panning bars respond as you move the mouse.

To cycle to Rotation, Thrust, or Panning control

- In the lower-right corner of the instrument panel, click the control readout to cycle to Rotation, Thrust, or Panning control.

Press to cycle to Rotation, Thrust, or Panning control.

Once you choose Rotation, Thrust, or Panning control, you can switch to Yoke mode and fly your spacecraft using the mouse.

A good tip to remember—when you are in Yoke mode and want to stop pitch and yaw, cut fine thrust, or stop panning, click the left mouse button.

To switch between Pointer and Yoke modes

- Click the right mouse button to switch between Pointer and Yoke modes.

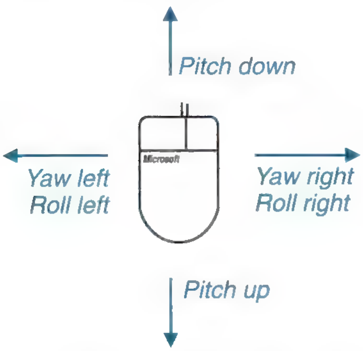
  When you are in Pointer mode, the mouse pointer is displayed on the screen.

  When you are in Yoke mode, the mouse pointer is no longer displayed. You can now change the direction of your spacecraft with the mouse.

Mouse Flight Controls in Yoke Mode

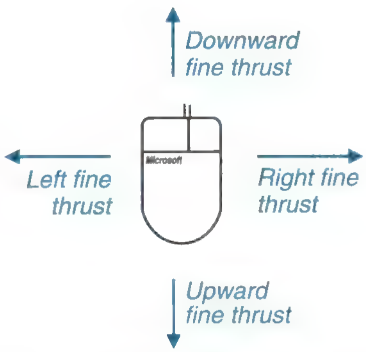
Move the mouse to control pitch and yaw. Hold down the CTRL key and move the mouse to control roll.

Click the left mouse button to stop pitch, yaw, and roll.



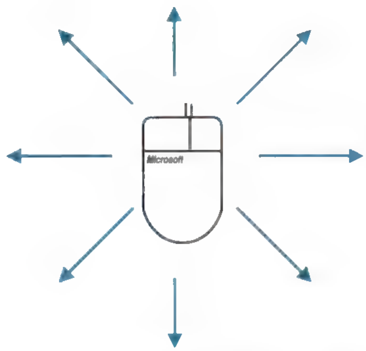
Move the mouse to control fine thrust.

Click the left mouse button to cut fine thrust.



Move the mouse to pan in the direction you want.

Click the left mouse button to stop panning.

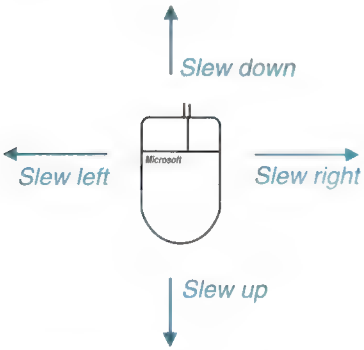


Mouse Observatory Controls in Yoke Mode

Before slewing the telescope, press the D key to switch from Tracking to Panning mode. In Tracking mode, your tracking object is always in the center of the screen, so slewing has no effect.

Move the mouse to slew your telescope left, right, up, or down.

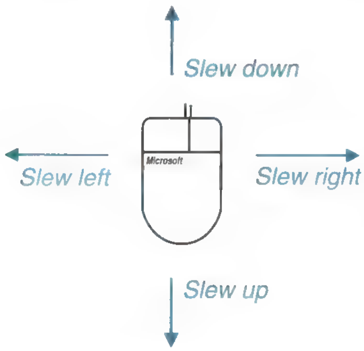
Click the left mouse button to stop slewing.



Your slewing motions follow the lines of right ascension and declination.

Move the mouse to slew your telescope left, right, up, or down.

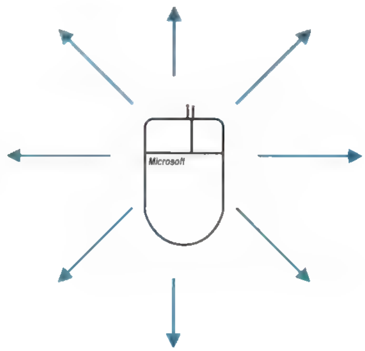
Click the left mouse button to stop slewing.



Your slewing motions follow the lines of altitude and azimuth.

Move the mouse to pan in the direction you want.

Click the left mouse button to stop panning.



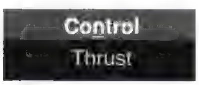
Panning lets you take a leisurely look at the sky without the telescope.

Using a Joystick

Use a joystick to control your spacecraft while you use the mouse to choose a menu or command.

In Space Simulator, you can use a joystick in conjunction with the control readout in the lower-right corner of the instrument panel to fly your spacecraft and change your views. You can control yaw, pitch, roll, fine thrust, and panning with the joystick, but you can only control main thrust with the keypad. For more information on the keys for thrust, see the "Keyboard Quick Reference" on the back cover of this book.

When the control readout is set on Rotation, you move the joystick forward or backward to control spacecraft pitch (nose down or up). You move the joystick left or right to control yaw (left or right turn). You hold down the CTRL key and move the joystick left and right to control roll (both when flying and when at the observatory). The rotation gauge on the instrument panel responds as you move the joystick.



When the control readout is set on Thrust, you move the joystick forward or backward to control downward or upward fine thrust. You move the joystick left or right to control left or right fine thrust. The fine-thrust gauge on the instrument panel responds as you move the joystick. Note that you cannot control forward or backward fine thrust with the joystick.

When the control readout is set on Panning, you move the joystick in the direction in which you want to pan. In Cockpit, Chase, and Assigned views, you can pan in any direction and see all around you. This viewing flexibility is called power panning. The panning bars respond as you move the joystick.

Press to cycle to Rotation, Thrust, or Panning control.

To cycle to Rotation, Thrust, or Panning control

- In the lower-right corner of the instrument panel, click the control readout to cycle to Rotation, Thrust, or Panning control.

Once you choose Rotation, Thrust, or Panning control, you can fly your spacecraft using the joystick.

Joystick Flight Controls

Move the joystick to control pitch and yaw. Hold down the CTRL key and move the joystick to control roll.

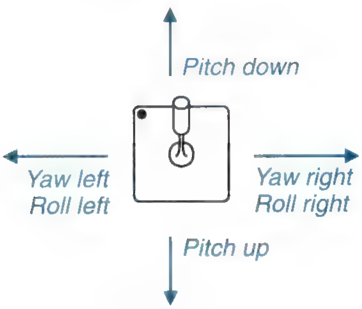
Center the joystick to stop pitch, yaw, and roll.

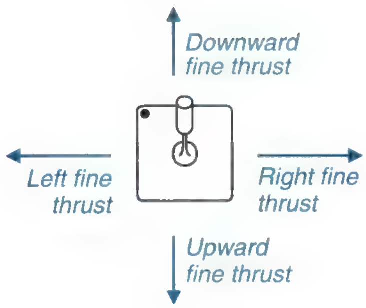
Move the joystick to control fine thrust.

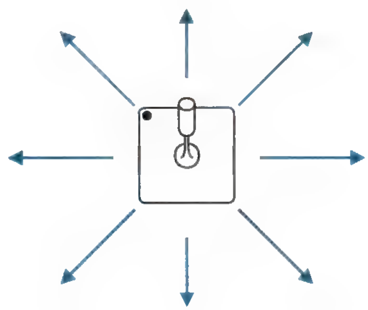
Center the joystick to cut fine thrust.

Move the joystick to pan in the direction you want.

Center the joystick to stop panning.





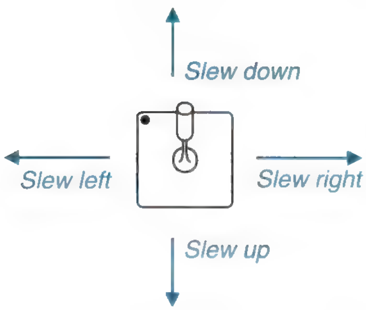


Joystick Observatory Controls

Before slewing the telescope, press the D key to switch from Tracking to Panning mode. In Tracking mode, your tracking object is always in the center of the screen, so slewing has no effect.

Move the joystick to slew your telescope left, right, up, or down.

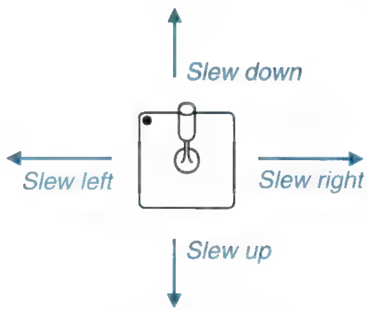
Center the joystick to stop slewing.



Your slewing motions follow the lines of right ascension and declination.

Move the joystick to slew your telescope left, right, up, or down.

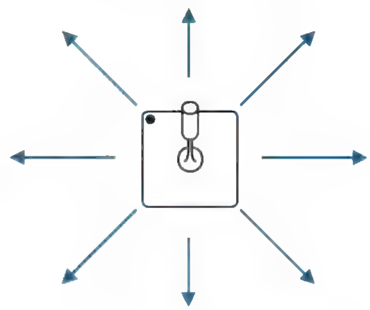
Center the joystick to stop slewing.



Your slewing motions follow the lines of altitude and azimuth.

Move the joystick to pan in the direction you want.

Center the joystick to stop panning.



Panning lets you take a leisurely look at the sky without the telescope.

Installing, Testing, and Calibrating a Joystick

Joysticks are either self-centering, which means that the stick returns to the center position when released, or noncentering. You can control pitch and yaw with either a self-centering or noncentering joystick.

Many joysticks have mechanical switching levers to turn the self-centering springs on or off. These switches are usually on the underside of the joystick case. You may be able to turn off the self-centering mechanism on joysticks that do not have switching levers. However, check with your joystick manufacturer before attempting any alteration.

Be sure to follow the manufacturer's installation instructions when installing your joystick.

To install a joystick

- Turn off your computer and follow the installation instructions included with your joystick.

After you've installed the joystick, you need to activate it and calibrate it for use with Space Simulator. Each brand of joystick has slight differences in feel, sensitivity, and response.

X-axis movement is sideways; Y-axis movement is forward and backward.

To test a joystick

- Slowly move your joystick through its complete X and Y ranges, watching the rotation gauge on the instrument panel as you move.

  The movements may be jumpy, and pushing the stick in a specific direction may not move the spacecraft in that direction. Calibration will solve these problems.

Calibrating your joystick is like tuning a piano. It corrects for any deviations from the standard.

To calibrate a joystick

J *Press to calibrate the joystick.*

1. From the Options menu, choose Preferences.

   Space Simulator displays the Preferences dialog box.

2. Under Category, choose Joystick.

   Space Simulator displays the Joystick Preferences dialog box.

3. Move the joystick to the center position.

4. Choose the Calibrate button, and then choose the OK button.

   Space Simulator adjusts your joystick and returns you to spaceflight.

You can change the sensitivity settings for the joystick. For more information, see "Adjusting Joystick Preferences" on page 63.

Appendix B
Accessibility for People with Disabilities

Microsoft is committed to making its products and services easier for everyone to use. This appendix provides information about the following products and services that make Microsoft products more accessible for people with disabilities:

- Microsoft support services for people who are deaf or hard-of-hearing
- Microsoft software documentation on audio cassettes and floppy disks
- Products available for people who are blind or have low vision
- Information about other products and services for people with disabilities

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Important The information in this section applies only to Space Simulator users in the United States. If you are outside the United States, your Space Simulator package contains a subsidiary information card listing product-support telephone numbers and addresses. You can contact your subsidiary to find out whether the type of products and services described here are available in your area.

Microsoft Support Services for People Who Are Deaf or Hard-of-Hearing

Through a text telephone (TT or TDD) service, Microsoft provides people who are deaf or hard-of-hearing with complete access to Microsoft's product- and customer-support services.

You can contact Microsoft support services using a text telephone by dialing (206) 635-4948 between 6:00 A.M. and 6:00 P.M. Pacific time. Microsoft's product-support services are subject to Microsoft's prices, terms, and conditions in place at the time the service is used.

Documentation on Audio Cassettes and Floppy Disks

People who cannot use printed documentation can obtain most of Microsoft's publications from Recording for the Blind, Inc. Recording for the Blind distributes these documents on audio cassettes or floppy disks to registered members of their distribution service. Recording for the Blind's collection contains more than 80,000 titles, including Microsoft product documentation and books from Microsoft Press. You can contact Recording for the Blind at the following address:

Recording for the Blind, Inc.	Phone:	(800) 221-4792
20 Roszel Road	Fax:	(609) 987-8116
Princeton, NJ 08540		

From outside the United States, you can contact Recording for the Blind at (609) 452-0606

Products for People Who Are Blind or Have Low Vision

There are numerous products available to help people who are blind or have low vision. For people with low vision, there are several screen-enlargement utilities, and for people who cannot use visual information, there are screen readers that provide alternative output by synthesized voice or refreshable Braille displays. For more information on the various products available, see the next topic, "Getting More Information."

Getting More Information

For more information on Microsoft products and services for people with disabilities, contact Microsoft Customer Sales and Service at (800) 426-9400 (voice) or (206) 635-4948 (text telephone).

The Trace R&D Center at the University of Wisconsin in Madison produces a book and a compact disc that describe products that help people with disabilities use computers. The book, titled *Trace Resource Book,* provides descriptions and photographs of about 2000 products. The compact disc, titled *CO-NET CD,* provides a database of more than 17,000 products and other information for people with disabilities. It is issued twice a year and is available in many public libraries.

You can contact the Trace R&D Center by using the following address or telephone numbers:

Trace R&D Center		
S-151 Waisman Center	Voice telephone:	(608) 263-2309
1500 Highland Avenue	Text telephone:	(608) 263-5408
Madison, WI 53705-2280	Fax:	(608) 262-8838

For general information and recommendations on how computers can help people with specific disabilities, you should consult a trained evaluator who can best match the individual's needs with the available solutions.

If you are in the United States, you can obtain information about resources in your area by calling the National Information System, an information and referral center for people with disabilities, at the following address:

National Information System (NIS)
Center for Developmental Disabilities
University of South Carolina, Benson Bldg.
Columbia, SC 29208

Voice/text telephone outside South Carolina:	(800) 922-9234
Voice/text telephone in South Carolina:	(800) 922-1107
Voice/text telephone outside the United States:	(803) 777-6222

Fax: (800) 777-6058

This service is available only in the English language.

Glossary

Terms printed in *italic* in the Glossary are defined elsewhere in the Glossary.

You can also find descriptions of specific stars, planets, moons, asteroids, and other objects in space by choosing relevant commands on the Location menu.

A

Acceleration The rate at which you change your speed in response to *thrust.* Acceleration is often measured in terms of *gravity.* One gravity (1 G) equals the acceleration required to negate the *gravitational force* of *Earth.* In spaceflight, thrust, acceleration, and *velocity* are three closely related terms.

Altitude The height above the surface of an object such as a *planet,* moon, or space station. Altitude differs from distance, which refers to the distance away from the center of an object. In Space Simulator, you use the distance readout on the reference display when you are far away from your reference object. When your spacecraft is within several *radii* of the reference object, you can switch to the altitude readout so that you know exactly how far you are from the surface.

Apogee Refers to the highest (or farthest away) point of an object's *orbit.* For example, if your spacecraft is in an *elliptical orbit* around *Neptune,* the apogee is the point at which you are the farthest distance from the *planet. Perigee* is the point in your orbital path at which you are the closest to Neptune (or whatever object you are orbiting).

Asteroid A small *planet.* Asteroids range in size from a few hundred meters in diameter to several hundred *kilometers.* Science-fiction writers of the 1940s and 1950s wrote many stories of adventurous space pioneers venturing to the asteroid belt between *Mars* and *Jupiter* in search of riches. This idea is not so far-fetched. Some asteroids are extremely rich in nickel-iron while others hold the most precious treasure of space: oxygen. Asteroid miners may be essential to the development of space.

Astronomical unit The average distance between the *Earth* and the *Sun,* which is 150 million *kilometers,* or about 93 million miles. This is a handy unit of measure to use when distances are so great that mere kilometers seem too small, but *light-years* seem too big.

Attitude The position of a spacecraft determined by the relationship between its axes (lateral, longitudinal, vertical) and a given reference point (for example, a particular *planet*). See also *lateral axis, longitudinal axis,* and *vertical axis.*

Autopilot An automatic navigation system that you can use to program and execute specific voyages and maneuvers. For example, you can set a course for *Jupiter* and then take a nap or tend to the hydroponic plants that you are transporting to the Galilean moons. The distances in space are so vast and the precision maneuvers so critical that all spacecraft in Space Simulator are equipped with an autopilot. You can link several autopilot maneuvers into a complete *flight plan* with the *flight computer.*

Azimuth A method of measuring an object's location horizontal to the horizon. Azimuth measurements begin with a reading of 0 degrees at the North Pole and progress in a clockwise direction for 360 degrees, with east lying at 90 degrees, south lying at 180 degrees, and west lying at 270 degrees. Azimuth is often used in association with *altitude,* which is a measurement of an object's distance above the horizon.

B

Big bang theory Holds that all the *galaxies* and other matter making up our *universe* came into existence about 20 billion years ago as a result of one very big bang. However, the theory doesn't address where all the stuff for the bang came from or how many times the universe might have gone bang before.

C

Celestial equator An imaginary plane extending infinitely into space as an extension of *Earth's equator.* The celestial equator, along with the celestial north and south poles, provides a means of describing the *universe* as it is seen from Earth. The celestial equator is used as the beginning point for measuring an object's *declination* from the celestial equator. A *star* right on the celestial equator has a declination of 0 degrees. A star directly above the Earth's North Pole (which can also be called the celestial north pole) has a declination of plus 90 degrees, while a star directly above the Earth's South Pole has a declination of minus 90 degrees.

Centripetal force The force that attempts to pull an object toward the center of its rotation. When speaking of the *Moon* orbiting *Earth,* this force is created by the *gravitational acceleration* of Earth. The stability of the *orbit* is maintained when the centripetal force exerted by the gravitational acceleration of Earth is balanced by the *momentum* of the Moon. The same forces are at play when a spacecraft orbits a moon or *planet.*

Chase craft A view location that lets you watch your spacecraft's every move from a chase vehicle tailing it at a set distance. Choose the Location button on the view tools to cycle to Chase view. Choose View Controls from the Window menu to set the chase craft distance.

Comet A mysterious traveler, a chunk of primordial ice that originated near the very beginning of time. The comets we see in our sky are captured by the *Sun's gravitational force,* although many have extremely eccentric *orbits* and travel billions of *kilometers* away from our Sun before being pulled back. The long tails often associated with comets are caused by gases and debris streaming away from the nucleus, or center, of the comet. These tails always point away from the Sun and grow longer as comets approach the Sun.

Constellation A configuration of *stars.* There are 88 formal constellations in the heavens. Constellations are a tribute to the fascination and sense of mystery that the heavens hold for humankind. Although it takes quite a bit of poetic license to see the images traditionally associated with the constellations, such as the lion of Leo or the hunter of Orion, they are still used as an astronomical means of dividing the sky.

D

Declination The celestial equivalent to latitude, measured in degrees north or south of the *celestial equator* (rather than the *Earth's equator*). Declination is measured to plus 90 degrees of the north celestial pole, and to minus 90 degrees of the south celestial pole.

Deep sky objects A term used in astronomy to describe objects (other than individual *stars*) that lie beyond our *solar system.* Deep sky objects include nebulas, star clusters, and galaxies. See also *galaxy* and *nebula,* or choose Deep Sky from the Location menu.

Deorbit burn An application of *thrust* in the opposite direction of your *orbit.* Also called a *retroburn,* its purpose is to slow the *velocity* of your spacecraft so that it deorbits from its current orbital path and enters into a lower orbital path. A deorbit burn is often used to create an orbital path that intersects with the surface of a *planet* or other object to provide a course for landing. When using Slew Control, you can initiate a deorbit burn by applying backward thrust. When using Flight Control, you can execute the deorbit burn with reverse *fine thrust* (which takes longer), or you can turn your spacecraft 180 degrees so that it is in a *retrograde* position prior to applying thrust with your main engines.

E

Earth The magnificent home *planet.* The Earth has a diameter of about 12,753 *kilometers* (7,926 miles) and an average distance from the *Sun* of 149.4 million kilometers (92.9 million miles). Its atmosphere is composed of oxygen and nitrogen. The planet is fragile. Handle with care!

Eccentricity Most *orbits* are *elliptical* (or oval) rather than circular in shape. Any deviation from a perfect circular orbit is called eccentricity.

The degree to which an orbit is eccentric is measured on a scale in which a perfectly circular orbit is 0 (zero) and an extremely flattened elliptical orbit approaches 1. For example, the elongated elliptical orbit of *Pluto* has an eccentricity of 0.248, while the nearly circular orbit of *Earth* has an eccentricity of 0.017. Orbits with eccentricity of 1 or higher are *parabolic* or *hyperbolic* orbits, which remain open and don't close back upon themselves.

Einstein, Albert (1879-1955) The wonderful genius who was able to visualize a *universe* where light could become matter and matter could become light ($E=MC^2$), and in which concepts such as time and distance have only relative meanings. For example, travelers near the *speed of light* can live extraordinarily long lives within a realm where time passes much more slowly than it does on *Earth.* Much of what Einstein theorized was proven years later when humans actually ventured into space, and astronomers peered deep enough into the universe to confirm what only Einstein's mind had seen.

Einstein's law of relativity Refers to Albert Einstein's two theories of relativity. His first, the special theory of relativity, was published in 1905, and is best known for its equation $E=MC^2$ (energy is equal to mass times the *speed of light* squared), in which Einstein showed the equivalence of accelerated mass and light. In 1916, Einstein published his more encompassing general theory of relativity, in which he incorporated the effects of *gravity* and *acceleration.*

Elliptical orbit Few *orbits* are perfectly circular—most are elliptical (oval). The more elliptical an orbit is, the greater its *eccentricity.* An elliptical orbit has a *perigee* (the closest point to the object it is orbiting) and an *apogee* (the farthest point from the object it is orbiting.)

Equator An imaginary circle or circular band dividing the surface of a body into two usually equal and symmetrical parts.

Equatorial orbit An *orbit* that circles above the *equator* of a *planet,* moon, or other object. The equator is the imaginary band that circles an object, midway between the object's north and south poles. An equatorial orbit is perpendicular to a *polar orbit.*

Equatorial plane The plane defined by a *radius* extending outward from the *equator* of a *star, planet,* or other object. For example, an *orbit* along the *Earth's* equatorial plane is one that circles the Earth midway between the North and South Poles.

Escape velocity The *velocity* required to break free from the *gravity* of a moon, *planet, star,* or other massive object. To achieve escape velocity, one must exceed the gravitational velocity exerted by the massive object. The escape velocity decreases, the farther your spacecraft is from the surface of the object.

Extravehicular activity (EVA) See *space walk.*

F

Fine thrust Provided by secondary thrusters for use in precision maneuvers. You use *thrust* from a spacecraft's main engines to travel across the *solar system,* but you use fine thrust when executing precision docking maneuvers or adjusting orbital position. In Space Simulator, you can add fine thrust with the keyboard, mouse, or joystick. Gauge your progress with the fine-thrust scale on the instrument panel.

Flight computer No spacecraft should be without one. The flight computer links several *autopilot* maneuvers into a unified *flight plan.* For example, you can set the autopilot for a launch, a destination, an orbital transfer, and a landing. All of these single autopilot instructions are combined into one flight plan with the flight computer.

Flight plan You can use Space Simulator's *flight computer* to assemble a series of specific *autopilot* instructions into one flight plan. Responsible star pilots never leave *orbit* without them (except when taking off for unknown destinations, just for the fun of it)!

G

Galaxy A collection of millions or billions of *stars* that rotate around a common gravitational center. A galaxy is like an island, a swarming of stars in a sea of utter emptiness. Our own galaxy is called the *Milky Way*.

Geosynchronous orbit Also called geostationary orbit. At an *altitude* of 35,881 *kilometers* (22,300 miles) above the surface of the *Earth*, a satellite's orbital speed is such that it retains its position above the same point on Earth. This synchronous and stationary *orbit* is already much used by communication satellites and would be a great location for future solar power stations. Some people call this orbital height "Clarke Orbit" in honor of British science-fiction author Arthur C. Clarke, who is credited with conceiving the idea of the geosynchronous orbit.

Globular cluster A magnificent ball of *stars*, gravitationally bound as a group. Omega Centauri, the largest and most magnificent globular cluster seen from *Earth*, is 17,000 *light-years* away, has a diameter of 150 light-years, and contains more than a million stars. In photographs, globular clusters appear to be jammed with stars, but actually, even at the core, the stars are separated by billions of *kilometers*.

Gravitational acceleration Acceleration induced by the *gravity* of an object. For example, a ball you toss into the air is brought down by the *Earth's* gravitational acceleration. Gravitational acceleration is determined by the mass of the object and your distance from it. The more massive the object, and the nearer you are to it, the greater the gravitational acceleration.

Gravitational force The term often used to describe the gravitational interaction between two objects. For example, the mass of our *Earth* is sufficient to exert an inescapable gravitational force for our *Moon*. Similarly, our *Sun* holds an inescapable gravitational force for the *planets*. When gravitational force is sufficient, an object is referred to as being gravitationally captured.

Gravity No one understands it, but the fact that all objects are attracted to each other appears to be an irresistible force of our *universe* (the greater the mass and the closer together the objects are, the greater the attraction). *Acceleration* is expressed in gravities (or Gs). One gravity of acceleration is required to negate the gravitational pull of the *Earth* at its surface. See also *Newton, Sir Isaac (1642-1727)*.

Gravity well A term used to describe the increased gravitational attraction that a massive object exerts the nearer a spacecraft (or any other object) gets to it. It is related to escape *velocity*, which is the velocity a spacecraft must achieve to escape the *gravitational force* of a *planet* or other object. In terms of space development, it has been said that establishing mining operations on the *Moon* could make sense financially because it is so expensive to lift raw materials out of Earth's gravity well.

Greenwich mean time See *Universal time*.

Ground speed A measurement of *velocity* in reference to a surface. For example, a spacecraft launched straight up from Cape Canaveral would have a great *radial velocity* (its velocity away from the starting point, *Earth*), but would have an insignificant ground speed until the spacecraft altered its *attitude* into a more horizontal position, at which point it would have a great ground speed, as it whizzed over the surface of the *planet* far below.

H

Heading The direction in which a spacecraft is pointed. This is not necessarily the direction in which the spacecraft is traveling.

Head-up display (HUD) A type of instrument display that is superimposed over an area of the cockpit windshield, letting a star pilot see flight-related information without taking his or her eyes off the flight path. Especially nice for dockings and other precision maneuvers.

Hohmann transfer A fuel-efficient method of space travel in which a satellite's or spacecraft's *orbit* is altered. For example, you can make a trip from *Earth* to *Mars* with a Hohmann transfer, in which your spacecraft's *orbit* around Earth is raised to the point at which it coincides with the orbit of Mars.

You can raise an orbit by applying *thrust* when the spacecraft is at *perigee,* which is sometimes called a *perigee burn.* You can circularize an orbit by applying thrust at the point of *apogee,* which is sometimes called an apogee kick.

Hyperbolic orbit A curved open *orbit* that has *escape velocity* so it doesn't close back on itself.

I

Interplanetary spacecraft A spacecraft that is capable of taking you from one *planet* to another, but that doesn't have the capacity to transport you through the vast distances to other star systems. Even though it is limited to our *solar system,* an interplanetary spacecraft must be well appointed with creature comforts. Remember the trip to *Pluto* is more than 4.8 million *kilometers* (almost 3 million miles).

Interstellar spacecraft A spacecraft that is capable of traveling the vast distances between one star system and another. An interstellar spacecraft must have powerful engines, a fine *autopilot* and *flight computer*, and plenty of books on board. A trip to one of our very nearest neighbors, the star Alpha Centauri, covers a distance of 4.3 *light-years* or about 32 quadrillion *kilometers* (20 quadrillion miles).

J

Joystick A control system consisting of a lever with buttons. In Space Simulator, you can use a joystick for *pitch*, *yaw,* and *roll* control of the spacecraft's *attitude.*

Jupiter The fifth *planet* out from the *Sun,* named for the king of the Roman gods. A gas giant and the largest of the nine planets, it has a diameter of 141,592 *kilometers* (88,000 miles) and an average distance from the Sun of 772 million kilometers (480 million miles). Jupiter has at least 17 moons, including the four large Galilean moons.

K

Kilometer In the metric system, one kilometer equals 1000 meters, or approximately 0.62 miles.

L

Lateral axis An imaginary line that extends horizontally through the spacecraft from left to right. Movement about the lateral axis controls the *pitch* (or nose-up and nose-down *attitude)* of your spacecraft.

Light-year The most frequently used method for measuring distances in space. A light-year is the measure of the distance that light travels in a vacuum in one year. Light travels in a vacuum at 299,792.5 *kilometers* (186,000 miles) per second, or 17,956,440 kilometers (11,160,000 miles) per minute, or 1,077,386,400 kilometers (669,600,000 miles) per hour, or 25,857,273,600 kilometers (16,070,400,000 miles) per day or 9,437,904,864,000 kilometers (5,865,696,000,000 miles) per year. You can also use the term "way far away." See also *speed of light.*

Local Group Our galactic neighborhood. A collection of about 20 of our nearest and dearest neighboring *galaxies,* beyond which is a great deal of empty space. Members of the Local Group include Andromeda, and the Large and Small Magellanic Clouds. The Local Group is spread across an area of space about 3.3 million *light-years* in diameter.

Longitudinal axis An imaginary line that extends horizontally through the spacecraft from the nose to the tail. Movement about the longitudinal axis controls the *roll* (side-to-side action) of your spacecraft.

Luna The *Earth's* Moon, which was named for Diana or Luna, the Roman goddess of the Moon. See *Moon.*

Lunar module Any vehicle used to travel between a spacecraft in lunar *orbit* and the surface of the *Moon.* A classic example is the lunar excursion module used in the Apollo space program to carry the first humans to the Moon and back.

M

Manned maneuvering unit (MMU) A backpack with small jet thrusters that allows an astronaut to propel him- or herself around in space while outside the spacecraft.

Work accomplished with an MMU is often referred to as a *space walk* or extravehicular activity (EVA).

Mars The fourth *planet* out from the *Sun,* named for the Roman god of war. Mars has a diameter of 6758 *kilometers* (4200 miles) and an average distance from the Sun of 227 million kilometers (141 million miles). Mars has two moons, Phobos and Deimos.

Mercury The nearest *planet* to the Sun, named for the messenger to the Roman gods. Mercury has a diameter of 4988 *kilometers* (3100 miles) and is believed to have virtually no atmosphere. It has an average distance from the Sun of 58 million kilometers (36 million miles).

Meter In the metric system, one meter equals 3.281 feet, or approximately 39.37 inches.

Milky Way Our wonderful galactic home that contains about 200 billion *stars.* The Milky Way is a spiral *galaxy,* believed to have a similar appearance to our neighboring galaxy, Andromeda. The Milky Way was named in ancient times when people looked up and saw the milk-white cloud of stars traversing the sky like a river.

Momentum Obtained by multiplying an object's *velocity* times its mass. This means that a 60-million ton *asteroid* moving at 60 *kilometers* per second has more momentum than a 200-pound *manned maneuvering unit* traveling at the same velocity. It also means that you should avoid an accidental meeting of these two momentums.

Moon The Moon has a diameter of 3475 *kilometers* (2160 miles) and has an average distance of 384,326 kilometers (238,860 miles) from the *Earth.* It is gravitationally captured by the Earth, yet exerts a *gravitational force* of its own. For example, the Moon's gravitational force causes the shifting tides of Earth's oceans. See *Luna.*

N

Nebula A cloud of interstellar gas (about 90 percent hydrogen, the rest helium) and dust. The Orion Nebula is so vast that 20,000 of our *solar systems* could be placed end-to-end within it. And at its center *protostars* are formed as they gravitationally attract hydrogen and dust, growing larger and hotter through this process.

Neptune The eighth *planet* out from the *Sun,* and sometimes the farthest, depending on *Pluto*'s orbit. Named for the Roman god of the sea, Neptune has a diameter of 49,235 *kilometers* (30,600 miles) and an average distance from the Sun of 4.5 billion kilometers (2.8 billion miles). Neptune has eight moons.

Newton, Sir Isaac (1642-1727) English mathematician and physicist whose extraordinary genius discerned the role of gravitation in organizing our *solar system* and *galaxy.* Newton laid the foundation upon which much of modern-day astronomy and astrophysics still stands.

Newton's first law of motion A law of physics stating that a body continues at rest or in uniform motion in a straight line unless acted upon by some force. What this means for space travel is that a spacecraft traveling at a *velocity* of 7000 *kilometers* (4351 miles) per second retains that velocity forever, unless *thrust* is applied in the reverse direction, or it is gravitationally captured by a *star* or *planet,* or it runs into a brick wall at the end of the *universe.*

Newton's law of gravitation States that the force of *gravity* between two objects is proportional to their combined masses, and inversely proportional to the square of the distance between them. This means that if you double the distance of your spacecraft from a *planet,* the *gravitational acceleration* exerted by the planet is only one fourth of what it was before.

O

Observatory A building with a rotating domed roof that opens for a view of the heavens through a high-powered telescope. In Space Simulator, the Observatory command lets you choose any viewing location you like.

Orbit The path of an object that is gravitationally captured by a greater object.

For example, the *Earth* has a predictable orbit around the *Sun,* the *Moon* has a predictable orbit around the Earth, and satellites gravitationally captured by Earth have a predictable orbit around it. See *gravitational force.*

P

Parabolic orbit A curved open *orbit* that has *escape velocity* so it doesn't close back on itself.

Perigee The point of closest approach between an orbiting object and the object it is orbiting. For example, if your spacecraft is in an *elliptical orbit* around *Neptune,* the point of perigee is at your nearest distance to the *planet.* The opposite of perigee is *apogee,* which is the farthest point of the *orbit.*

Perigee burn The application of *thrust* at the point of *perigee.* You can use perigee burn to raise (or elongate) an *orbit,* for example, when executing a *Hohmann transfer.*

Pitch The nose-up and nose-down movement of a spacecraft about its *lateral axis.*

Planet Generally, a planet is a large nonstellar object that orbits a *star,* while a moon is a large object that orbits a planet. Coming close to this category are the larger *asteroids* (or minor planets) of our own *solar system,* which *orbit* the *Sun* but aren't considered large enough to be planets. Someday, when we travel to other solar systems, it may be difficult to draw the line between what is a planet and what is an asteroid. And is a huge comet in another solar system considered to be an icy planet? At this point, the nine planets of our own solar system are the only known planets, but many astronomers predict that greater telescopes, or space probes, will someday reveal that planets are commonly found around stars.

Planetarium A model or representation of the *solar system.* An *observatory* often includes a planetarium where *stars* are projected against a domed ceiling and the paths of the *planets* are shown as they travel their *orbits* around the *Sun.* In Space Simulator, you can choose the Observatory command from the Options menu to watch the planets move through the sky at the location and time that you specify.

Pluto The ninth *planet* out from the *Sun,* named for the Greek god of the underworld. Pluto has a diameter of 2301 *kilometers* (1430 miles) and an average distance from the Sun of 5.8 billion kilometers (3.6 billion miles). Pluto has one moon, Charon.

Polar orbit An orbit that circles above an object, crossing over its north and south poles. A polar orbit is perpendicular to an *equatorial orbit.*

Prograde Refers to orbital direction in relation to another orbiting object. Prograde means to *orbit* in the same direction. For example, if you want to orbit in the same direction as a *planet,* establish a prograde orientation with the planet. To make a prograde adjustment to an orbit is to apply thrust to your current direction of travel, which increases your orbital *velocity.*

Protostar A star begins as a seed that slowly attracts smaller elements of matter (mostly hydrogen) toward itself. The larger a protostar becomes, the greater its gravitational reach, and the more hydrogen, helium, and interstellar dust it can pull into its own making. The Orion *Nebula* is a stellar nursery in which a number of protostars are nursing their way toward young adulthood by feeding on the nebula's vast cloud of hydrogen.

R

Radial velocity Refers to your spacecraft's *velocity* either toward or away from your reference object. A *radius* is a straight line emanating from the center of an object, hence the terminology of radial velocity as a guide to how you are progressing either toward or away from the reference object. In Space Simulator, you can check your spacecraft's radial velocity on the velocity gauge, which also displays *tangential velocity.*

Radius, radii The radius of an object is equal to one half its diameter. In terms of space travel, the radius refers to the distance from the center of an object, such as a *planet,* to its surface. Radii is the plural of radius.

Radii is a handy measurement—look for it on Space Simulator's reference display. If you are three radii from a planet, you are close, but still safely above the surface.

Reentry Refers to returning from a flight beyond the atmosphere and then reentering the atmosphere. A reentry can be demanding because of the friction and heat caused by the density of an atmosphere. Whether landing on *Earth, Mars,* or a *planet* in one of Space Simulator's other *solar systems,* use caution during a reentry if you are flying with your skill level set for either intermediate or advanced. If you reenter an atmosphere with too much *velocity,* your spacecraft will experience a temperature crash and turn into a ball of fire.

Relativity See *Einstein's law of relativity.*

Retroburn The application of *thrust* while your spacecraft is in a *retrograde* orientation with its current direction of travel. For example, if you are flying from the first *planet* in the Polaris *solar system* to the third planet, you can turn your ship around halfway there and execute a retroburn to slow your spacecraft for arrival.

Retrograde Refers to orbital direction in relation to another orbiting object. Retrograde means to *orbit* in the opposite direction of an object. For example, if you want to orbit in the opposite direction of a *planet,* establish a retrograde orientation with the planet. To make a retrograde adjustment to an orbit is to apply *thrust* against your current direction of travel, which decreases your orbital *velocity.*

Right ascension The celestial equivalent to longitude. As with longitude, it can be measured in either hours, minutes, and seconds, or in degrees, minutes, and seconds. Just as longitude has a zero point at Greenwich, England, right ascension has a zero point measured from the first point of Aries, which marks the position of the *Sun* as it crosses the *celestial equator* during the spring (or vernal) equinox.

Roll The movement of a spacecraft about its *longitudinal axis.* For example, if you are traveling to *Mars* in a straight line, you can roll your ship as you travel to change your view or to make your passengers dizzy.

S

Saturn The sixth *planet* out from the *Sun,* named for the Roman god of reaping. Saturn has a diameter of 114,239 *kilometers* (71,000 miles), and an average distance from the Sun of 1426 million kilometers (886 million miles). Saturn is best known for its magnificent rings, which are composed of ice particles orbiting the planet in as many as 100 separate rings, which together create the magnificent sight that we see from an *Earth* telescope, or in the photographs returned from Voyager 1. Saturn has at least 22 moons.

Situation A Space Simulator file that you can save with your location, spacecraft, and spacecraft settings, and return to at a later point. For example, you might want to save and revisit a situation in which you fly an *interplanetary spacecraft* in *orbit* just above the rings of *Saturn.*

Slewing At the observatory, slewing means turning a telescope about its base, but slewing is also a method of changing spacecraft position, direction, location, or altitude in Space Simulator without having to worry about the physics of space travel or *gravity.* For the latter type of slewing, turn on the Slew Control command on the Flight menu.

Slingshot A maneuver in which a spacecraft approaches a *planet* from behind and uses the *gravity* of the planet to "slingshot" onward with a greater *velocity* than it had before the encounter.

Solar system A *star* with a group of celestial bodies that are captured by its *gravitational force.* Our solar system consists of the *Sun* and the nine *planets* orbiting it, and all the associated moons, *comets,* and *asteroids* gravitationally captured by our Sun.

Space walk When an astronaut leaves a spacecraft for open space. For example, an astronaut can use a *manned maneuvering unit (MMU)* to perform a space walk. Also referred to as extravehicular activity (EVA).

Specific impulse The efficiency of a rocket engine, measured in pounds of *thrust* per pound of propellant. The higher the specific impulse the better—the same thrust with less expenditure of fuel.

Speed of light Believed by Albert *Einstein* to be the ultimate universal speed limit that nothing can exceed. Light travels at 299,792.5 *kilometers* (or 186,000 miles) per second. A *light-year* is the measure of how far light can travel within the *vacuum* of space in one year, which is about 9.46 trillion kilometers. Despite the unimaginable speed of light, it still takes light from even the nearest *stars* more than four years to reach *Earth,* while it takes light from the neighboring Andromeda Galaxy more than two million years to reach Earth.

Star A glowing ball of hydrogen. It is believed that once the seed of a star (or *protostar*) begins to form within massive clouds of hydrogen, it gravitationally pulls more and more hydrogen into itself. The more massive it becomes, the stronger the *gravitational force* becomes, and the more hydrogen it pulls into itself. A star is like a nuclear furnace in which hydrogen atoms fuse together, releasing vast quantities of energy.

Sun Worshipped since the dawn of civilization as the giver of life. Life as we know it on *Earth* couldn't exist without the Sun's radiant heat. 1.5 million *kilometers* in diameter, the Sun is an average *star* now into its middle age (about five billion years old). In another five billion years, the Sun is expected to explode into old age and become a red giant. The bad news is that, at this magnitude, its heat will torch the land masses and boil away the seas, ending all life on Earth. The good news is that we have five billion years to find a new place to live.

Supernova An unimaginably cataclysmic explosion in which a massive *star* (perhaps a million times larger than our Sun) exhausts its hydrogen fuel. With its hydrogen furnaces halted, it can no longer support its own mass and begins to collapse into its core. This creates such extreme pressure that the star goes supernova in an incredible explosion that flings the star's remnants out into the sea of space where they soar as gossamer filaments—reminders of a long-gone star.

T

Tangential velocity Refers to *velocity* tangential to, or apart from, the reference object. For example, if you are in a perfect circular *orbit* around *Earth,* your spacecraft registers a steady tangential velocity, and no *radial velocity.* If you are in an *elliptical orbit,* both the tangential and radial velocity fluctuate. In Space Simulator, you can check your spacecraft's tangential velocity on the velocity gauge, which also displays *radial velocity.*

Temperature crash See *Reentry.*

Thrust The application of force against an object to give it motion. In spaceflight, the application of thrust results in the *acceleration* of the spacecraft. Thrust, acceleration, and *velocity* are three closely related terms.

U

Universal time The standard measurement of time used on *Earth* and in astronomy. Also known as Greenwich mean time. It's a measurement based on the passage of the *Sun* over the zero longitude, or the prime meridian, that passes through the Royal Observatory in Greenwich, England. To convert Universal time, add 5 hours if you live in New York City, add 8 hours if you live in Los Angeles, and subtract 9 hours if you live in Tokyo. If you live in Paris or London, standard time is the same as Universal time.

Universe A mysterious space of unknown dimensions (current theories place it at perhaps 20 billion *light-years* of diameter), which somehow contains all the *galaxies* ever seen or imagined. Many aspects of the universe remain a puzzle: Did it all begin with a *big bang*? Will it all collapse back on itself as a big crunch? What existed before the big bang? What will exist after a big crunch? The questions are old but enduring: Where did the universe come from? Where will it go? And what might be humanity's role within it?

Uranus Seventh *planet* out from the *Sun,* named for the oldest and most ancient Roman god, who was the father of *Saturn* and the grandfather of *Jupiter.* Also known as Father Sky. Uranus has a diameter of 51,488 *kilometers* (32,000 miles) and an average distance from the Sun of 2.9 billion kilometers (1.8 billion miles). Uranus has at least 15 moons and its own ring system, similar to, but smaller than, Saturn's.

V

Vacuum The near-complete emptiness of space, especially in intergalactic space, where the emptiness is so complete that there may be less than a single hydrogen atom per cubic *kilometer.* Just for comparison, the *Earth's* atmosphere can contain quintillions of atoms.

Velocity The speed, or rate, at which an object travels from one place to another. Velocity is sometimes confused with *acceleration.* Velocity refers to a steady rate of travel, while acceleration refers to an increase in velocity. Within the *vacuum* of space, an object retains its velocity forever, unless acted upon by another force.

Venus The second *planet* out from the *Sun,* named for the Roman goddess of love and beauty. It has a diameter of 12,100 *kilometers* (7520 miles) and an average distance from the Sun of 108 million kilometers (67 million miles).

Vertical axis An imaginary line that extends vertically through a spacecraft from top to bottom. Movement about the vertical axis controls the *yaw* (turning to the left or right) of your spacecraft.

Y

Yaw The sideways movement of a spacecraft about its *vertical axis*. In space, a left or right turn is described as yawing to the left or yawing to the right.

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Microsoft Support Services

If you have a question about Microsoft Space Simulator 1.0, first look in this manual. You can also find late-breaking updates and technical information in the README file that came with your Space Simulator 1.0 disks. If you cannot find the answer, contact the Microsoft Support Network.

Outside the United States, contact Microsoft Product Support Services at the Microsoft subsidiary office that serves your area. For information about Microsoft subsidiary offices, see "Product support worldwide" at the end of this chapter.

The Microsoft Support Network

The Microsoft Support Network offers you a wide range of choices and access to high-quality, responsive technical support. Microsoft recognizes that support needs vary from user to user; the Microsoft Support Network allows you to choose the type of support that best meets your needs, with options ranging from electronic bulletin boards to annual support programs.

Services vary outside the United States and Canada. In other locations, contact a local Microsoft subsidiary for information. The Microsoft Support Network is subject to Microsoft's then-current prices, terms, and conditions, and is subject to change without notice.

Product support within the United States and Canada

In the United States and Canada, the following support services are available through the Microsoft Support Network:

Electronic services

These services are available 24 hours a day, 7 days a week, including holidays.

Microsoft FastTips (800) 936-4100 on a touch-tone telephone. Receive automated answers to common questions, and access a library of technical notes, all delivered by recording or fax. You can use the following keys on your touch-tone telephone after you reach FastTips:

To	Press
Advance to the next message	*
Repeat the current message	7
Return to the beginning of FastTips	#

CompuServe Interact with other users and Microsoft support engineers, or access the Microsoft Knowledge Base to get product information.

At any ! prompt, type **go microsoft** to access Microsoft forums, or type **go mskb** to access the Microsoft Knowledge Base. For an introductory CompuServe membership kit, call (800) 848-8199, operator 519.

Microsoft download service Access, via modem, the Driver Library and the most current technical notes (1200, 2400, or 9600 baud; no parity; 8 data bits; 1 stop bit). In the United States, call (206) 936-6735. In Canada, call (905) 507-3022.

Internet Access the Driver Library and the Microsoft Knowledge Base. The Microsoft Internet FTP archive host, ftp.microsoft.com, supports anonymous login. When logging in as anonymous, you should type your complete electronic mail name as your password.

Standard support

In the United States, no-charge support from Microsoft support engineers is available via a toll call between 6:00 a.m. and 6:00 p.m. Pacific time, Monday through Friday, excluding holidays.

- For technical support for Microsoft Space Simulator, call (206) 637-9308

In Canada, support engineers are available via a toll call between 8:00 a.m. and 8:00 p.m. Eastern time, Monday through Friday, excluding holidays. Call (905) 637-3503.

When you call, you should be at your computer and have the appropriate product documentation at hand. Be prepared to give the following information:

- The version number of the Microsoft product that you are using
- The type of hardware that you are using
- The exact wording of any messages that appeared on your screen
- A description of what happened and what you were doing when the problem occurred
- A description of how you tried to solve the problem

Priority support

The Microsoft Support Network offers priority telephone access to Microsoft support engineers 24 hours a day, 7 days a week, except holidays.

- In the United Sates, call (900) 555-2000; $2 (U.S.) per minute, $25 (U.S.) maximum. Charges appear on your telephone bill. Not available in Canada.
- In the United States, call (800) 936-5700; $25 (U.S.) per incident, billed to your VISA card, MasterCard, or American Express card. In Canada, call (800) 668-7975; $30 per incident, billed to your VISA card, MasterCard, or American Express card.

Text telephone

Microsoft text telephone (TT/TDD) services are available for the deaf or hard-of-hearing. In the United States, using a TT/TDD modem, dial (206) 635-4948 between 6:00 A.M. and 6:00 P.M. Pacific time, Monday through Friday, excluding holidays. In Canada, using a TT/TTD modem, dial (905) 568-9641 between 8:00 a.m. and 8:00 p.m. Eastern time, Monday through Friday, excluding holidays.

Other support options

The Microsoft Support Network offers annual support plans. For information, in the United States, contact the Microsoft Support Network Sales and Information group at (800) 936-3500 between 6:00 A.M. and 6:00 P.M. Pacific time, Monday through Friday, excluding holidays. In Canada, call (800) 668-7975 between 8:00 a.m. and 8:00 p.m. Eastern time, Monday through Friday, excluding holidays.

Product support worldwide

If you are outside the United States and have a question about a Microsoft product, first:

- Consult the documentation included with your product.
- Check the README files that come with your product disks. These files provide general information that became available after the books in the product package were published.
- Consult electronic options such as CompuServe forums or bulletin boards, if available.

If you cannot find a solution, you can receive information on how to obtain product support by contacting the Microsoft subsidiary office that serves your country.

The Microsoft Support Network

The Microsoft Support Network, where available, offers you a wide range of choices and access to high quality, responsive technical support. Microsoft recognizes that support needs vary from user to user; the Microsoft Support Network allows you to choose the type of support that best meets your needs, with options ranging from electronic bulletin boards to annual support programs.

The Microsoft Support Network is subject to Microsoft's then-current prices, terms, and conditions in place in each country at the time the services are used and is subject to change without notice.

Calling a Microsoft subsidiary office

When you call, you should be at your computer and have the appropriate product documentation at hand. Be prepared to give the following information:

- The version number of Microsoft product that you are using
- The type of hardware that you are using, including network hardware, if applicable
- The operating system that you are using
- The exact wording of any messages that appeared on your screen
- A description of what happened and what you were doing when the problem occurred
- A description of how you tried to solve the problem

Microsoft subsidiary offices and the countries they serve are listed below.

If there is no Microsoft office in your country, please contact the establishment from which you purchased your Microsoft product.

For this country	Use this number
Argentina	(54) (1) 815-1521
Australia	(61) (02) 870-2131
Austria	0222 0660-6738
Belgium	(Dutch) 02-5133274 (English) 02-5023432 (French) 02-5132268
Bolivia	See Argentina
Brazil	(55) (11) 871-0090
Canada	1 (905) 568-3503
Caribbean	(214) 714-9100
Chile	56 2 218 5771
Colombia	(571) 618 2255
Denmark	(45) (44) 89 01 11
Dubai	(971) 4 513 888
England	See United Kingdom
Finland	(358) (0) 9 0 525 501
France	(33) (1) 69-86-10-20
French Polynesia	See France
Germany	089 - 3176 - 1170
Greece	(30) (1) 6893 635
Hong Kong	(852) 804-4222
Ireland	See United Kingdom
Israel	972-3-575-7034
Italy	(39) (2) 26901351
Japan	(81) (3) 5454-2337
Korea	(82) (2) 531-4800
Liechtenstein	See Switzerland

For this country	Use this number
Luxembourg	
(Dutch)	(32) 2-5133274
(English)	(32) 2-5023432
(French)	(32) 2-5132268
México	(52) (5) 325-0910
Netherlands	
(Dutch)	02503-77877
(English)	02503-77853
New Zealand	64 (9) 357-5575
No. Ireland	See United Kingdom
Norway	(47) (22) 02 25 50
Papua New Guinea	See Australia
Paraguay	See Argentina
Portugal	(351) 1 4412205
Republic of China	(886) (2) 508-9501
Republic of Ireland	See United Kingdom
Scotland	See United Kingdom
South Africa	(27) 11 444 0520
Spain	(34) (1) 803-9960
Sweden	(46) (8) 752 09 29
Switzerland	
(German)	01-342-0322
(French)	022-738 96 88
Turkey	(90) 212-2585998
United Kingdom	(44) (734) 271000
Uruguay	See Argentina
Venezuela	58.2.910046
Wales	See United Kingdom

Microsoft Space Simulator Troubleshooting Guide for Setup

Memory requirements

To install and run Microsoft Space Simulator, the recommended configuration for your computer is at least 550 kilobytes (K) of free conventional memory available (with an additional 21K for sound), and 768K configured as expanded memory (EMS). In addition, you need 15 megabytes (MB) of space on your computer's hard drive.

If your computer does not have sufficient free conventional memory or sufficient free disk space, Space Simulator reports the problem and stops. Before you can run Space Simulator, you need to free up 550K of conventional memory by reconfiguring your computer.

Extended and expanded memory

Most of today's computers are configured with memory beyond 640K. This memory is referred to as extended memory (XMS). Space Simulator requires that you configure *extended* memory as *expanded* memory. You can do this using the memory utilities provided with MS-DOS versions 5.0 and 6.0, or you can use third-party expanded-memory utilities.

To reconfigure your computer using MS-DOS version 5.0 or earlier

With MS-DOS version 5.0, you can load MS-DOS into extended memory, and thereby free up additional conventional memory for Space Simulator. MS-DOS version 5.0 comes with EMM386, a utility that helps you configure your system for expanded memory.

1. At the MS-DOS prompt, type **edit c:\config.sys**
2. Add the following lines to the top of the CONFIG.SYS file (if necessary):

   DEVICE=C:\DOS\HIMEM.SYS

   DOS=HIGH,UMB

   DEVICE=C:\DOS\EMM386.EXE RAM 768
3. From the File menu, choose Save.
4. Restart your computer to make the changes take effect.

If you still don't have sufficient memory to run Space Simulator, or if you are using MS-DOS version 4.0 or earlier, remove any terminate-and-stay resident (TSRs) and device utilities from your CONFIG.SYS or AUTOEXEC.BAT file. For more information, refer to your *Microsoft MS-DOS User's Guide*.

To reconfigure your computer using MS-DOS version 6.0

MS-DOS version 6.0 is designed to help you configure your system for optimum performance. It comes with Memmaker, a utility designed to help you free up memory and configure your system for expanded memory.

1. At the MS-DOS prompt, type **memmaker**
2. Choose the Express Setup option and follow the instructions.
3. Make sure that you configure your computer to run with expanded memory.

After Memmaker configures your system, it reports the amount of free conventional memory. This is likely to be greater than 550K, which means that your computer now has sufficient memory to run Space Simulator.

Creating a System Startup Disk

If you are not able to free up sufficient memory or do not want to modify your CONFIG.SYS or AUTOEXEC.BAT files in order to run Space Simulator, you can create a system startup disk (or boot disk) and use it to start your system when you run Space Simulator.

1. Insert Microsoft Space Simulator Disk 3 into your 3.5-inch disk drive.
2. Change to the drive where you inserted Disk 3.

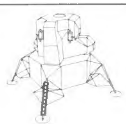
   For example, if Disk 3 is in drive A, type **a:** and then press ENTER.
3. To run the MAKEBOOT program and create a system startup disk, type **makeboot** and then press ENTER.

   Follow the instructions, making sure that you insert a blank disk into the disk drive when requested.
4. When MAKEBOOT is complete, insert the new system startup disk into the disk drive and restart your computer.

   You will need to use this disk to start your computer every time you run Space Simulator.
5. After your system starts, if you have not already run the Setup program, insert Microsoft Space Simulator Disk 1 - Setup into your 3.5-inch disk drive and type **setup**

   Follow the instructions to install Space Simulator.

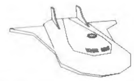
Note If your system does not run properly, it may be configured to use devices required in your CONFIG.SYS file (for example, a disk-doubling utility such as Stacker®). If this is the case, you can create your own system startup disk following instructions in the *Microsoft MS-DOS User's Guide*.



For information on Microsoft Support Services, please refer to the section following the index in the back of this manual.

Microsoft Space Simulator Keyboard Quick Reference

For a complete and convenient guide to all the keys you'll need for flying, slewing, or viewing the stars from your spacecraft or the observatory, choose Keyboard Guide from the Help menu.



Spaceflight and slewing controls

Spaceflight and slewing controls are virtually the same. The only difference is that to slew, you must first choose Slew Control from the Flight menu or press the Y key.

To do this	Press
Increase thrust	KEYPAD PLUS SIGN or F7
Decrease thrust	KEYPAD MINUS SIGN or F6
Full thrust	END or F8
Cut thrust	HOME or F5
Fine thrust forward	SHIFT+KEYPAD PLUS SIGN
Fine thrust backward	SHIFT+KEYPAD MINUS SIGN
Fine thrust up/down	PAGE UP/PAGE DOWN
Fine thrust left/right	INSERT/DELETE
Cut fine thrust	HOME or F5
Pitch up/down	DOWN ARROW/UP ARROW
Yaw left/right	LEFT ARROW/RIGHT ARROW
Roll left	KEYPAD SLASH (/) or F9
Roll right	KEYPAD ASTERISK (*) or F10
Stop pitch, yaw, roll	KEYPAD 5 or F3
Stop velocity	F4

Other controls

To do this	Press
Switch between distance/ radius and altitude	ALT+S
Accelerate time scale	F1
Decelerate time scale	F2
Set time scale to 1.1 yrs/sec	SHIFT+F1
Set time scale to 1 sec/sec	SHIFT+F2
Autopilot on/off	Z
Vehicle transfer	SHIFT+T
Undock	SHIFT+U
Space walk or reboard craft	SHIFT+W
Deploy or retract lander	SHIFT+D
Extend or retract landing gear	G
Sound on/off	Q
Calibrate joystick	J
Pause simulation	PAUSE
Reset simulation	CTRL+ESC
Exit Space Simulator	CTRL+BREAK

View and window controls

To do this	Press
Full Screen View on/off	W
Labels on/off	L
Open View 1 or make it active	1
Open View 2 or make it active	2
Open Map View or make it active	M
Turn on the instrument panel	I
Cycle through Cockpit, Chase, and Assigned views	S
Switch between Panning and Tracking modes	D
Head-up display on/off	H
Choose map origin	O
Choose a reference object	ALT+R
Choose a tracking object	T
Cycle through tracking objects	PERIOD (.)/COMMA (,)
Change chase craft distance	ALT+MINUS SIGN/ ALT+PLUS SIGN
Change Assigned view location	A
Zoom in	PLUS SIGN
Zoom in fast	SHIFT+PLUS SIGN
Zoom out	MINUS SIGN
Zoom out fast	SHIFT+MINUS SIGN
Return to normal magnification	ZERO (0)
Pan up	ALT+UP ARROW
Pan down	ALT+DOWN ARROW
Pan left	ALT+LEFT ARROW
Pan right	ALT+RIGHT ARROW
Center view	ALT+KEYPAD 5

Video and camera controls

To do this	Press
Record a video	R
Play a video	P
Stop recording or playing a video	BACKSLASH (\)
Pause a video	U
Take a space photograph	PRINT SCREEN

* 5 1 7 0 8 *

Recyclable Paper

Microsoft